Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JUL 28 1942

The WEAN ENGINEERING COMPANY, Inc. WARREN, OHIO

SUBSIDIARY THE BABCOCK CONSTRUCTION CO. CLEVELAND

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

ARMOR PLATE LEVELLERS

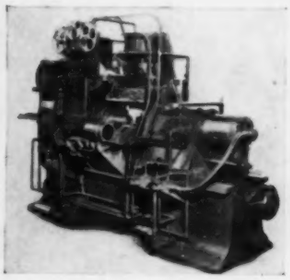
HIGH-SPEED SHEET AND TIN MILL SHEAR LINES

ELECTROLYTIC CONDITIONING TIN PLATE EQUIPMENT

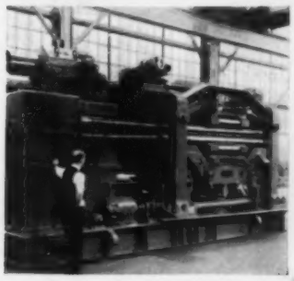
WILSON TUBE ANNEALING FURNACES

WEAN VACUUM CUP SHEET AND PLATE LIFTERS

CONTINUOUS STRIP PICKLING, SLITTING, SIDE TRIMMING, AND RECOILING LINES

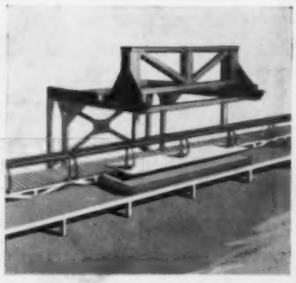


Shell and Sleeve Lathe



Armor Plate Leveller

Wilson Tube Type Annealing Furnace



Wean Vacuum Cup Sheet and Plate Lifter

For Victory!

UNITROL

REG. U. S. PAT. OFF.

Vital to Maximum Production

LET THIS TIME-SAVING, SPACE-SAVING, PRODUCTION-SAVING METHOD OF HOUSING AND CENTRALIZING MOTOR CONTROL SERVE YOU NOW

R v.13² July-Sept. 1942

Every moment of delay, every extra and unnecessary machining, assembling and installation operation, every unnecessary interruption to vitcl production, every diversion of manpower from production to maintenance now assume tremendous importance. They must be eliminated. That is why men responsible for the fate of America's production effort are turning to Unitrol . . . the modern and better way of housing, installing and centralizing Motor Control.

Whether it's Motor Control for a single machine or Motor Control for an entire factory, Unitrol makes the task of its installation, servicing, change, extension or contraction so much easier that plant after plant is adopting Unitrol.

For those who don't know the many contributions of Unitrol to speed, space and production, there's the 32-page booklet "Unitrol . . . the next step forward in Motor Control progress" . . . free for the asking. Only, *ask for it now*. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee, Wis. *Associate*: Canadian Cutler-Hammer, Ltd., Toronto.

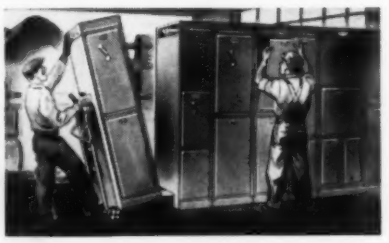
1892—1942 50TH ANNIVERSARY

Tech

Unitrol is a *better* method of mounting, housing and *centralizing* Motor Control . . . from the individual unit up to the complete plant-serving motor control center. It is made up from standardized interchangeable parts. It is complete and usable at every step of the way. It is inexpensive, speedy and easy to install, demount or change. It is as "flexible as a rubber band."

The individual Unitrol *Section* houses Motor Control for several motors or motorized machines, is compact, space-saving, convenient and economical. No supports, no other structures or preparation necessary.

← The individual Unitrol mounting frame is *better* for machines with built-in Motor Control. It eliminates many machining, wiring and assembling operations.



The complete Unitrol Control Center houses all the control and control equipment in the plant, for easy, speedy man-power-saving installation, maintenance, change, expansion or curtailment. No wall or floor preparation. No racks, trellises or frames. Permits installation of more than double as much control in same space.

CUTLER-HAMMER
UNITROL
C-H

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Warning:

"CUTTHROAT" MERCHANDISE

If this war ends up with the score tied . . . if the enemy is not *completely* defeated . . . look out for this invader!

Dictator-products, "cutthroat" merchandise cheaply made by slave labor, can destroy our standard of living as easily as high explosives.

The answer to this threat is a just peace . . . plus American ingenuity, using more efficient machines to produce better goods for more people.

Yale Pump Division Delivers Goods a Year Ahead of Schedule

Significant of America's ability to combat the threat from abroad with increased production are the many industries — ourselves among them — who have outproduced their own schedules for the Armed Forces.

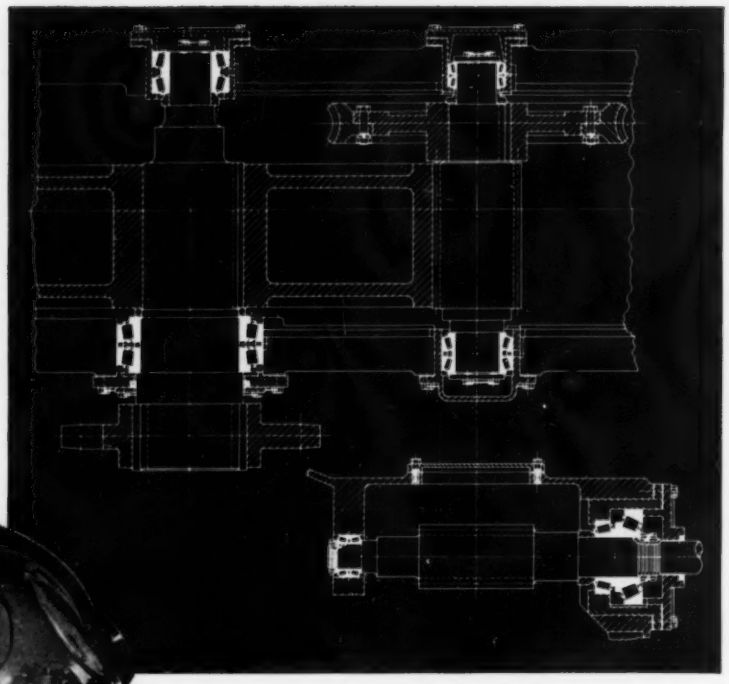
We are proud of this record achieved cooperatively in the American manner.

Tomorrow, the same cost-cutting, time-saving advantages of Yale Pumps that are helping win the war will be available to solve the fluid-handling problems of peacetime industry.

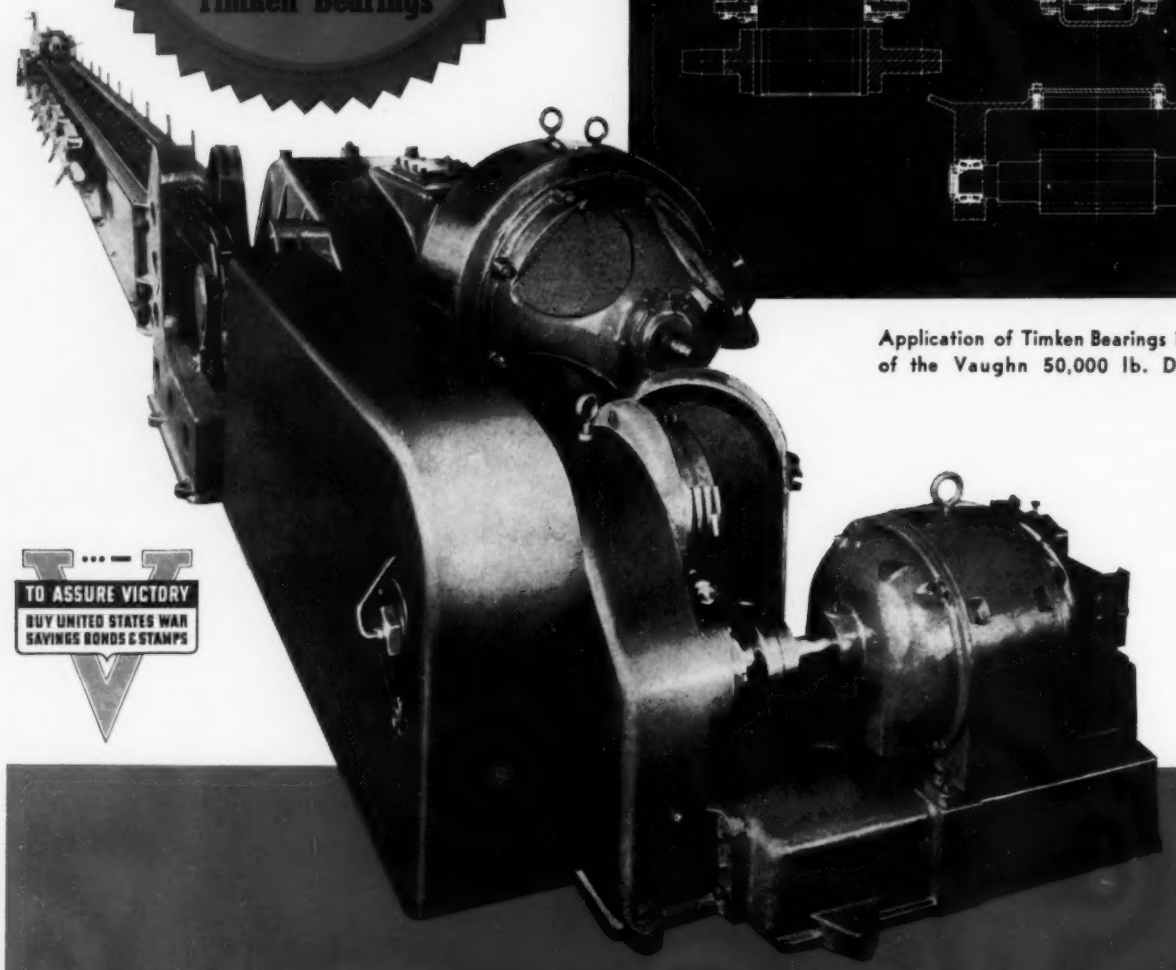
THE YALE & TOWNE MANUFACTURING COMPANY
STAMFORD, CONNECTICUT, U. S. A.

Pump Division

Give your equipment greater speed and endurance for Victory — and the competition that may follow it. Redesign to include more Timken Bearings



Application of Timken Bearings in the drive of the Vaughn 50,000 lb. Draw Bench.



TO ASSURE VICTORY
BUY UNITED STATES WAR SAVINGS BONDS & STAMPS

Steel manufacturers know the advantage of having Timken Tapered Roller Bearings in their equipment—from huge rolling mills to auxiliary equipment of all kinds.

Machinery builders, too, know that it pays to use Timken Bearings; they make *better selling* as well as *better operating* machines.

The Vaughn 50,000 lb. Draw Bench shown here is equipped with Timken Roller Bearings in the drive and at other important points. This is a case for precision as well as endurance. Timken Bearings assure both.

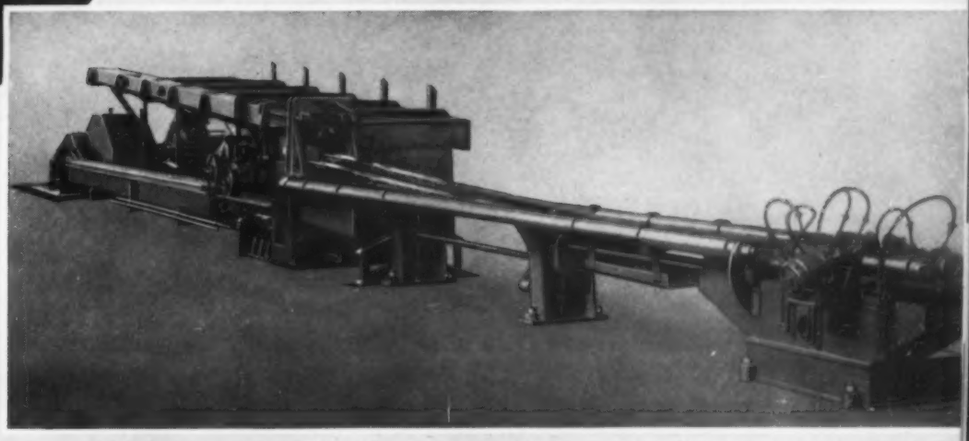
THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

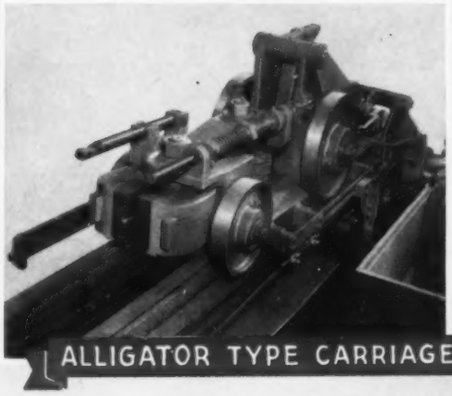
Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

SOME OF THE MANY *Features* THAT HAVE MADE AETNA *Drawbenches* OUTSTANDING. . . .

MANDREL ROD HOLDER ★

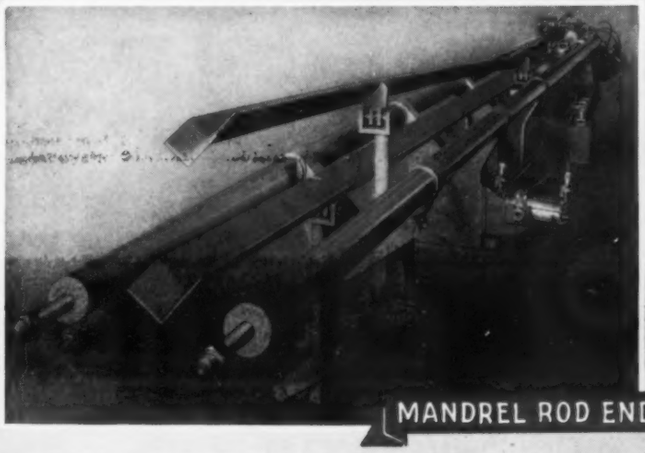




ALLIGATOR TYPE CARRIAGE

AETNA builds drawbenches having pulling capacity from 10,000 to 300,000 pounds for drawing ferrous and non-ferrous tubes and bars.

TILTING or NON-TILTING DISCHARGE ARMS ★



MANDREL ROD END "SEE-SAW" ★

HERRINGBONE GEAR DRIVE

DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES

The AETNA-STANDARD ENGINEERING COMPANY

★ YOUNGSTOWN, OHIO, U.S.A. ★

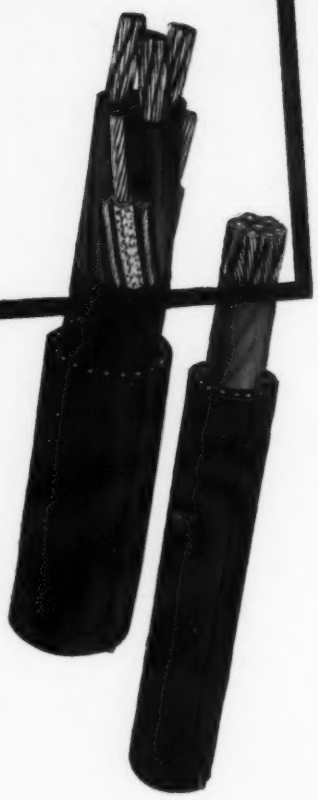
ASSOCIATED COMPANIES

HEAD, WRIGHTSON & COMPANY, LIMITED
THORNABY-ON-TEES, ENGLAND

JOHN INGLIS COMPANY, LIMITED
TORONTO, ONTARIO, CANADA

★ FULLY PROTECTED BY U.S. PATENTS
2,224,838 — 2,196,155 — 2,262,432

More Ways to Get Longer Life From Your Rubber-Covered Cords and Cables



Make the most of all your insulated wires and cables today. It saves you money, time and helps the whole war drive. Call on Okonite Engineers to help you install, operate and maintain all of your electrical circuits most efficiently.

Don't Abuse Cords—Protect cords from being run over by heavy moving equipment, dragged around sharp corners, yanked to remove kinks. While Okocord rubber-sheathed cords and cables are built to take tough service, abuse shortens their life unnecessarily.

Watch Out for Ozone— Keep your cords and cables, as much as is practical, away from high voltage equipment and sparking motors. Such machines generate ozone which attacks rubber and hastens its deterioration.

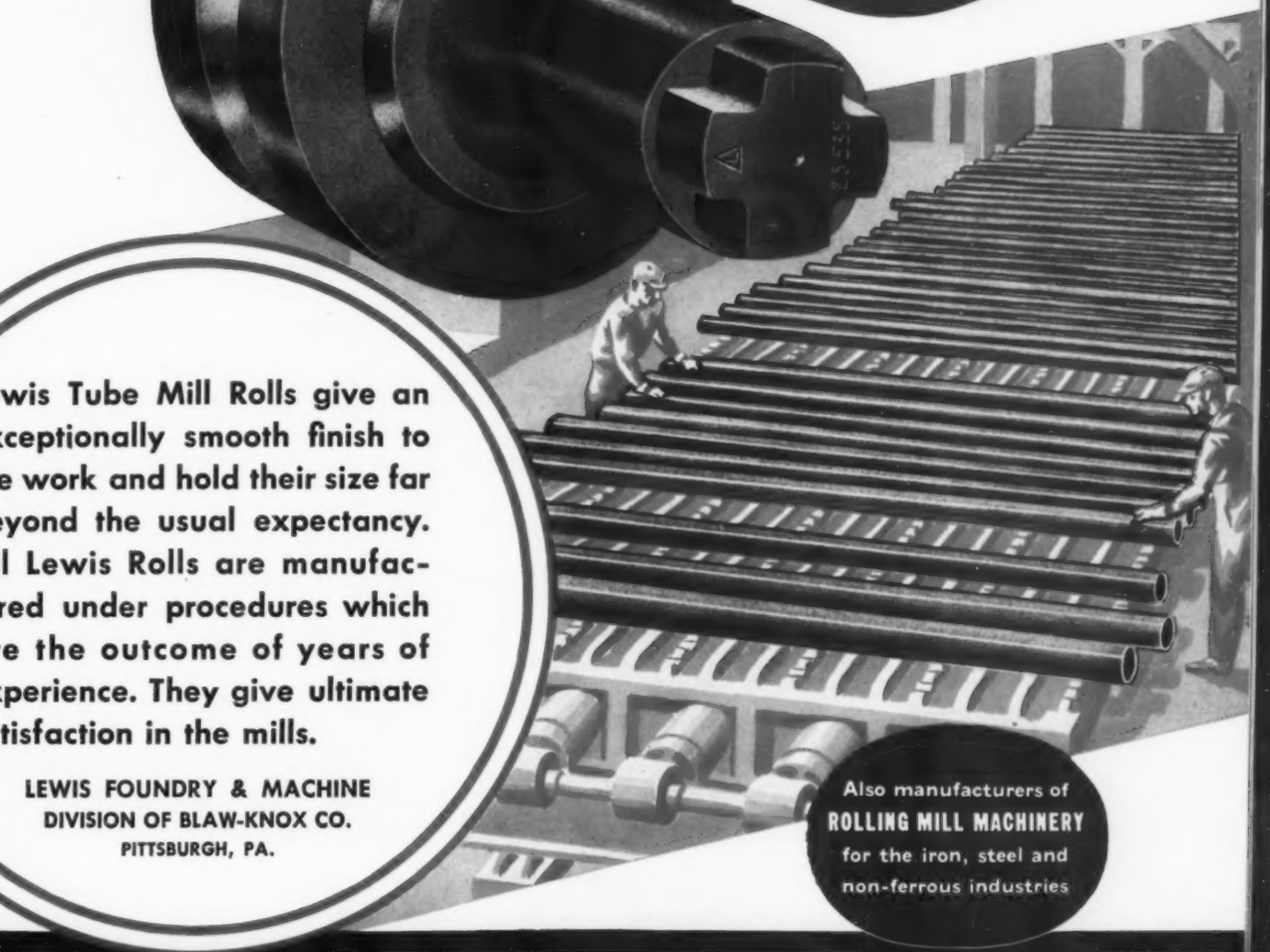
Avoid Short Diameter Flexing— Don't run cords and cables over small diameter pulleys or drums. Continued bending and flexing around a short radius breaks the conductors. Use larger diameter pulleys and get longer service from cords.

THE OKONITE COMPANY
Offices in principal cities
Passaic, N. J.

OKONITE
Insulated Wires and Cables

Lewis ROLLS

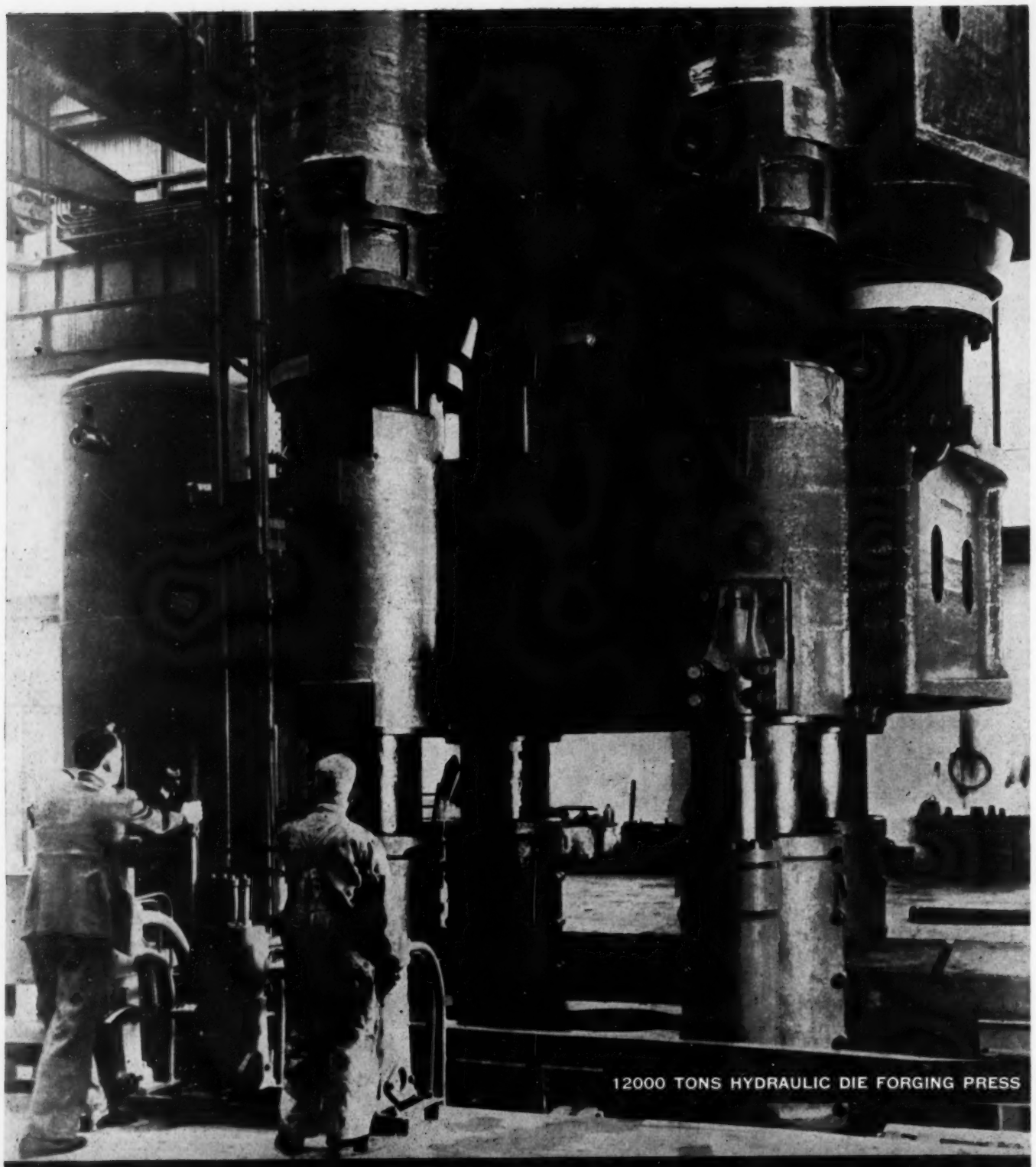
BETTER FINISH INCREASED TONNAGE



Lewis Tube Mill Rolls give an exceptionally smooth finish to the work and hold their size far beyond the usual expectancy. All Lewis Rolls are manufactured under procedures which are the outcome of years of experience. They give ultimate satisfaction in the mills.

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PA.

Also manufacturers of
ROLLING MILL MACHINERY
for the iron, steel and
non-ferrous industries



HYDROPRESS · INC.

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS
PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N Y

Are You Buying New Cranes?

IF SO—Specify COMPLETE WAGNER HYDRAULIC BRIDGE BRAKING SYSTEMS

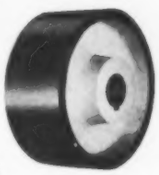
The Wagner Hydraulic Bridge Braking System is complete in every detail. It comes to you ready to install, and includes everything necessary—brake assembly, brake wheel, master cylinder, wheel cylinder, copper tubing, flexible hose, brake fluid and all fittings. The system is easy to install and any brake maintenance man can make the installation.

The Wagner Hydraulic Bridge Braking System assures positive braking action, smooth stopping, and controllable deceleration, to all types of overhead and whirler cranes. It will pay you to investigate if you are planning on new cranes or conversion from mechanical brakes.

TYPE H

BRAKE ASSEMBLY

Type H for inside cranes and type HM, where parking brake is necessary, for outside cranes.



BRAKE WHEEL

Furnished with bore as specified.

HYDRAULIC PARTS AND FLUID

All hydraulic parts and fluid needed for installation.

Write For Complete Literature

Bulletin IU-20 contains complete design, installation, adjustment, and service information on Wagner Hydraulic Bridge Braking Systems. This valuable bulletin should be in the hands of all design, production, safety, and maintenance engineers . . . Write for your copy today.

MAIL COUPON TODAY

Wagner Electric Corporation 142-3 I&SE

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

Gentlemen:

Please send me my copy of ☐ Bulletin IU-20 on Wagner Hydraulic Bridge Braking Systems, ☐ and place my name on the list to receive the Wagner Brake-O-Gram (a periodical bulletin on the operation, care, and maintenance of bridge brakes.)

*Name*_____ *Position*_____

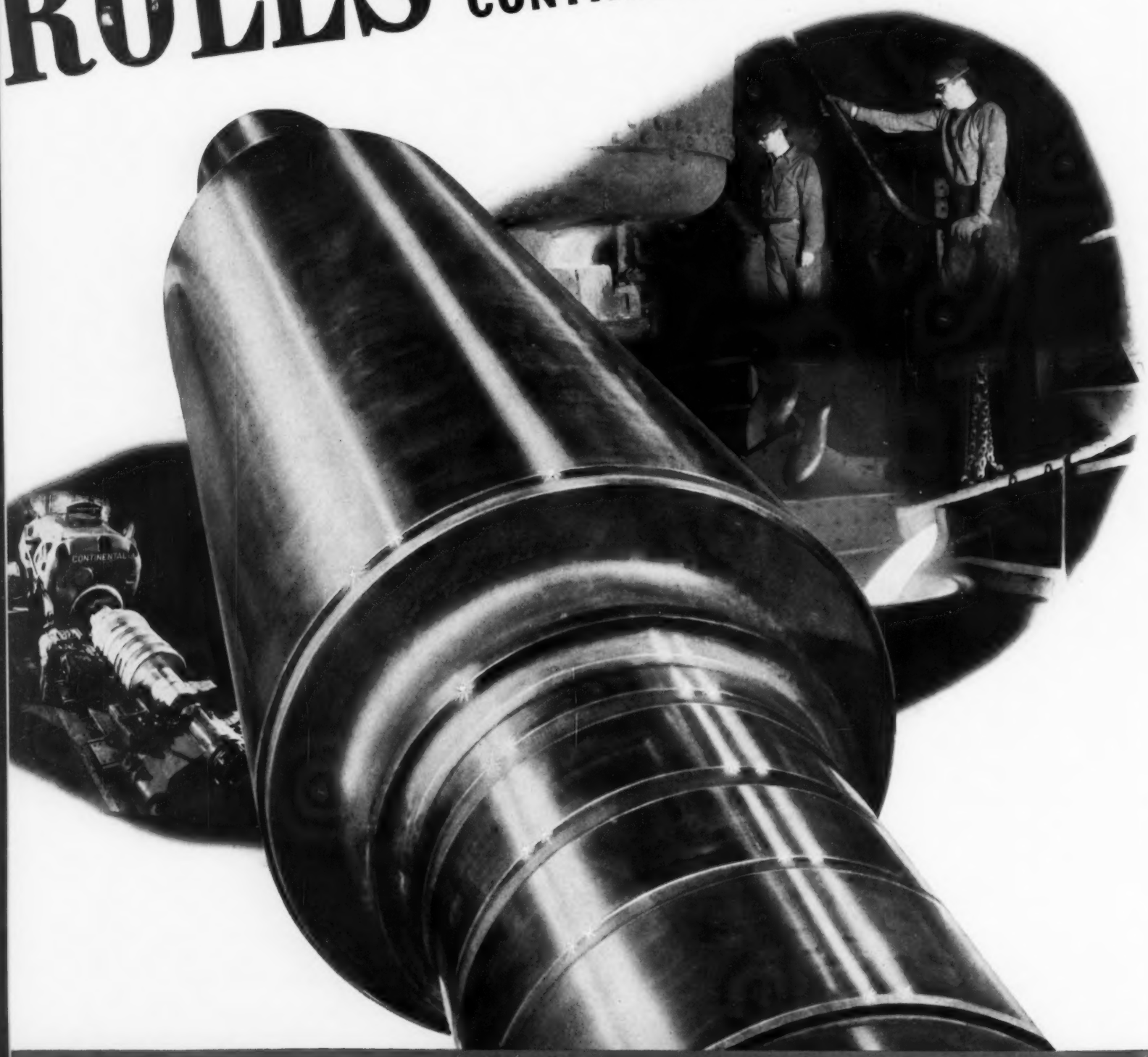
*Company*_____

*City*_____ *State*_____

Branch Offices in 25 Principal Cities

ROLLS

A VITAL PART OF CONTINENTAL'S PRODUCTION



CONTINENTAL

ROLL AND STEEL FOUNDRY COMPANY

CHICAGO • PITTSBURGH

ROLLS • ROLLING MILL EQUIPMENT • SPECIAL MACHINERY

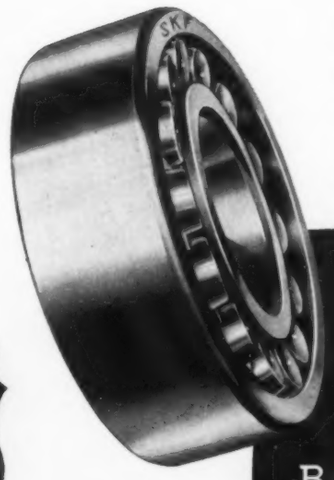
Built by
United Engineering & Foundry Co.

WELL-DESIGNED to Fight In the Battle for Production

Today—with CONTINUOUS service and peak demand—steel manufacturers appreciate the many advantages of a reliable Gear Reduction Drive—United's 3000 h.p. double reduction double input drive that's built to stand up under the terrific punishment meted out in the Battle for Production. They also appreciate the fact this drive has SKF Spherical Roller Bearings on all shafts. SKF's built-in alignment compensates for shaft movement without binding. Full load carrying capacity is always available. And gear life is extended because original shaft centers are maintained. The well-designed product is SKF-equipped . . . always.

5086

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA.



SKF

BALL AND ROLLER BEARINGS

Moloney Power Transformers

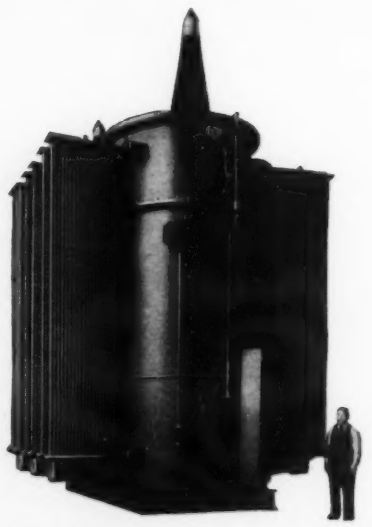
are on the job supplying power to vital war industries

Electric Power is basic to production. It multiplies man power; it supplies energy to the machinery that produces tanks, planes, ships, and guns.

The more power America utilizes for war production, the harder our blows at the Axis will become. The Moloney Electric Company is producing a steady stream of power transformers in its cooperative effort to bring the war to a victorious close by the Allied Nations—*quickly.*

Utilities, industrial plants, and power generating sources now using Moloney Power Transformers appreciate the extra life and dependability built into every Moloney Power Transformer. We are justly proud of our product and are striving together with all other Americans to supply our boys with more and better equipment with which to win the war.

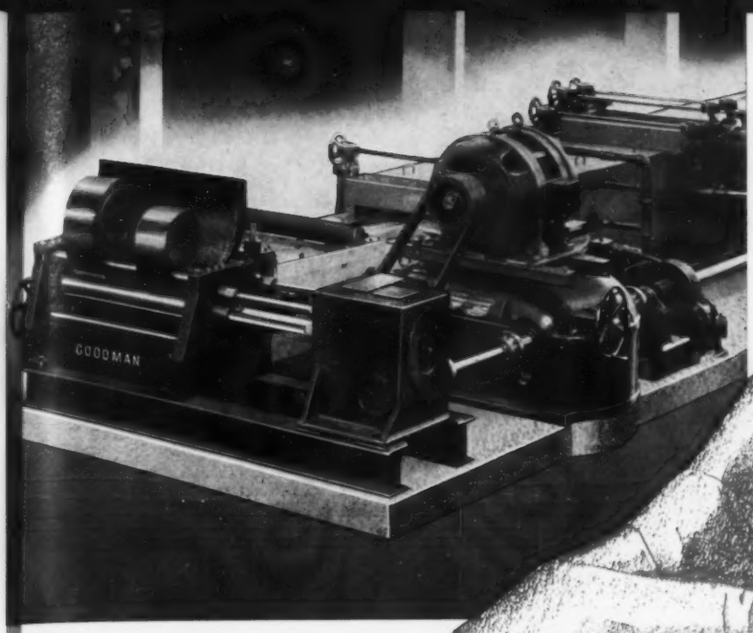
If you need power transformers that will stand up under any and all operating conditions, and need them *in a hurry,* write to us today.



Above is one of three 25,000 Kva transformers rated 161,000 Y to 13,200 volts.

MOLONEY ELECTRIC COMPANY • ST. LOUIS, U. S. A.

POWER AND DISTRIBUTION TRANSFORMERS EXCLUSIVELY SINCE 1896



THE WAY TO *Faster* PRODUCTION *Quality* PRODUCTION

GOODMAN

CONTINUOUS STRIP PICKLERS

Give you **BOTH**

The revolutionary Goodman method of strip treating gives remarkable results in production and quality. *More than 30* of these pickling machines are in use on vital defense materials.

- No stopping to stitch coils together.
- No stopping to dump acid for fresh supply.
- Greater speed by mechanical removal of loosened scale at intervals during process.
- Easy access for removal of residue from pickling.
- Maximum production obtained by utilizing machine's ability to run single wide strand or double narrow strand.

Covered by Goodman patents and licensed exclusively under Revere patents.

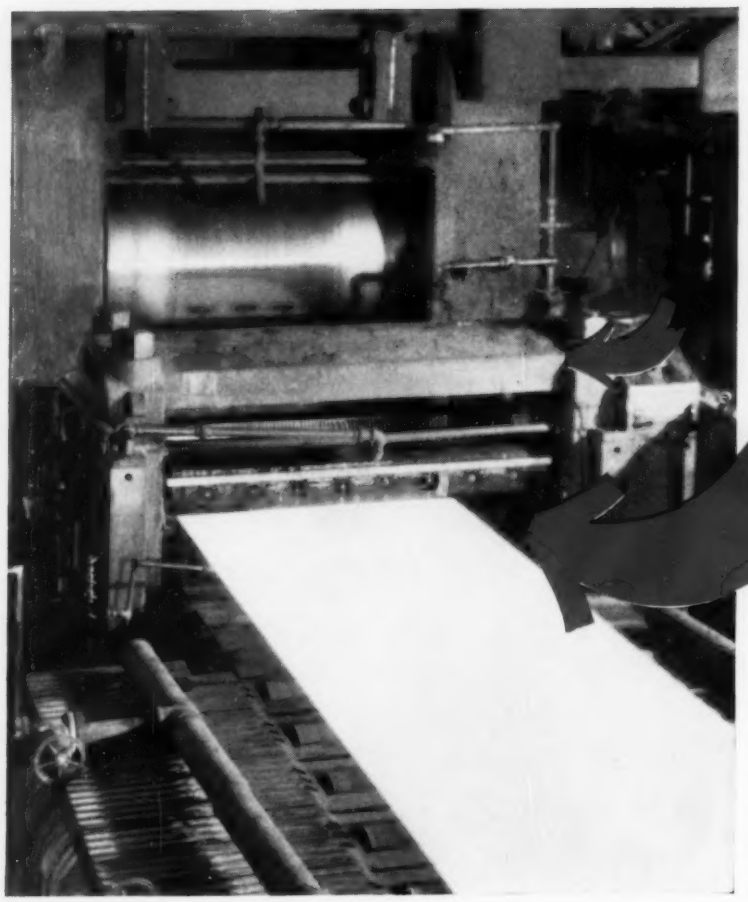
GOODMAN MANUFACTURING COMPANY

Industrial Manufacturing Division

ENGINEERS AND BUILDERS OF EQUIPMENT FOR STEEL AND NON-FERROUS INDUSTRIES

CHICAGO, ILLINOIS

More Tons per Grind



with Heppenstall Shear Knives

Heppenstall Shear Knives stay sharper longer . . . deliver more tons per grind, because they are made of the finest special analysis alloy steel in Heppenstall's own electric induction furnaces. Heppenstall knives are forged, annealed, machined, heat treated, and ground with extreme care and advanced methods developed through more than fifty years of quality shear knife manufacture.

Without obligation to you, call upon Heppenstall Service Engineers to help you solve shearing problems. And next time you order, specify Heppenstall. Use knives of guaranteed quality . . . save time and money. Write for full information. Heppenstall Co., Box E8, 4620 Hatfield Street, Pittsburgh, Pennsylvania.

Heppenstall

PITTSBURGH DETROIT BRIDGEPORT

HEPPENSTALL H QUALITY

Forging Fine Steels For More Than Fifty Years

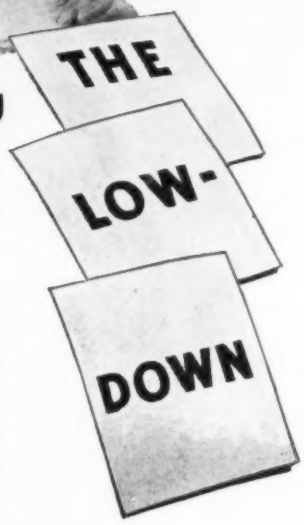
LESS COST PER TON OF STEEL ROLLED RAILS

Phoenix Rolls stand squarely on their records of service. The most worthwhile recommendations for Phoenix Rolls come directly from men who use them.

PHOENIX ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.

Cleveland owners give you



"You've certainly come to the right place to get the low-down on Cleveland Worm Gear Speed Reducers" cordially remarks the Manager of a Midwest plant, "because we have used a lot of them over a good many years.

1—"*We bought fifty Clevelands* on our first order, nearly 20 years ago. That was a big initial order for those days, but we needed 50 and were confident that Cleveland made a very superior Drive.

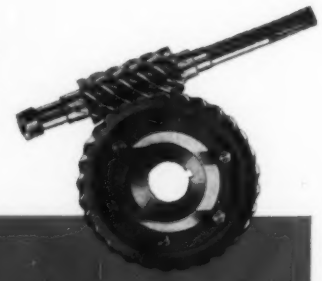
2—"Since then, we have ordered additional Clevelands repeatedly.

3—"Cleveland Drives operate our machines uniformly. Smoothness is vital to our grinding and polishing processes.

4—"We have no shutdowns due to Drive failure."

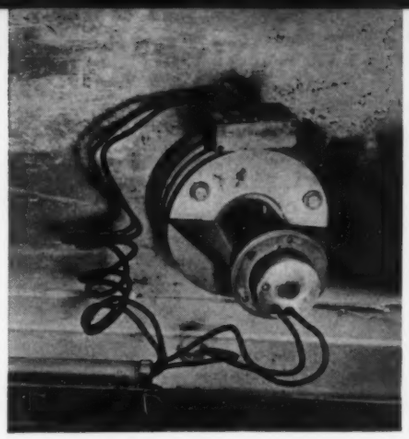
Cleveland has devoted its entire 30 years to producing worms and gears and nothing else. Their good qualities have led this and many another manufacturer to order more Clevelands—dozens or hundreds—after the first purchase.

The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland, Ohio.



Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication.
In Canada: PEACOCK BROTHERS LIMITED

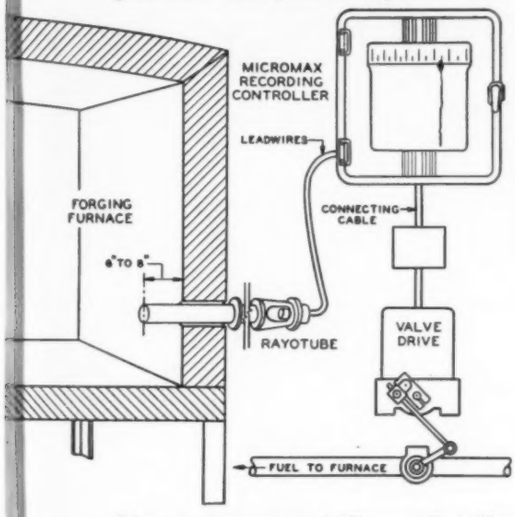
CLEVELAND WORM GEAR *Speed Reducers*



Rayotube installed on a forging furnace, Steel Improvement & Forge Co., Cleveland.

Rayotubes Are Ideal With Micromax Pyrometers for Many Furnace-Control Jobs

Whenever a furnace's pyrometer is using a thermocouple as the temperature-sensitive element, and the couple is not giving satisfactory service, it's a good idea to investigate the use of a Rayotube. For this detector gives greatly superior results in many cases. There isn't space here to give details, but the diagram shows one specific example.



Schematic arrangement of Micromax Controlling Pyrometer, regulating temperature in an oil-fired forging furnace and using a Rayotube to detect temperature. Note that Rayotube proper is outside furnace, merely "looking" in at a closed-end target tube which is at full temperature.

The furnace is one of many, used for the heating of forging stock in the shop of Steel Improvement & Forge Co., Cleveland. Thermocouples, used in these furnaces, used to break because of vibration from the forging hammers. When Rayotubes became available, they were tried, and won on two scores. First, they don't break, burn out, or corrode; they outlast 'couples many times over. Second, they're much more sensitive than 'couples, so that control of temperature is closer, quicker, more accurate.

If you have a problem in which Rayotubes possibly could serve you, see Catalog N-33B, or write us.

This foreman is responsible for annealing of steel, in a plant where annealing furnaces must run for days at an unbroken stretch. He prefers Micromax Pyrometers (on panel behind him), for controlling temperature of the furnaces because they are fully dependable as well as fully automatic; release much of his time for other work.

FOR "ALL-OUT" HELP TO BUSY MEN,

Micromax Pyrometers Guard Their Own Dependability

The Micromax Pyrometers shown above operate for days at a time without the touch of a human hand. They do so because they have, inside themselves, automatic "hands" which attend to routine needs.

Every potentiometer pyrometer, for instance, needs an occasional "standardizing," because its operating cells change in voltage as they are used. So, in Micromax, a gear train performs the standardizing operation, *automatically*. And it does this every 45 minutes—much oftener than a man would; oftener even than is necessary if the operating cells are at their best level of performance. But very new operating cells, or very old ones, or ones which have been frozen, baked or otherwise damaged, have no long-sustained level. So, Micromax takes no chances on any cell. It standardizes so frequently that any one gives good service until it's exhausted.

And, as a cell approaches exhaustion, a signal appears on the pyrometer, calling for attention. Similarly, advance warning is given when fresh chart is going to be needed; or more ink; and if electric power is off, thus stopping the pyrometer, that fact can be seen. And there are many other automatic "hands" in Micromax.

Not all of these features are necessary, or even advisable, for all applications, however, and for that reason we make Micromax in four models, in addition to the Strip-Chart (Model S) shown above. You can thus find a Micromax for almost any furnace-control problem. We'll be glad to help on request, in the selection.

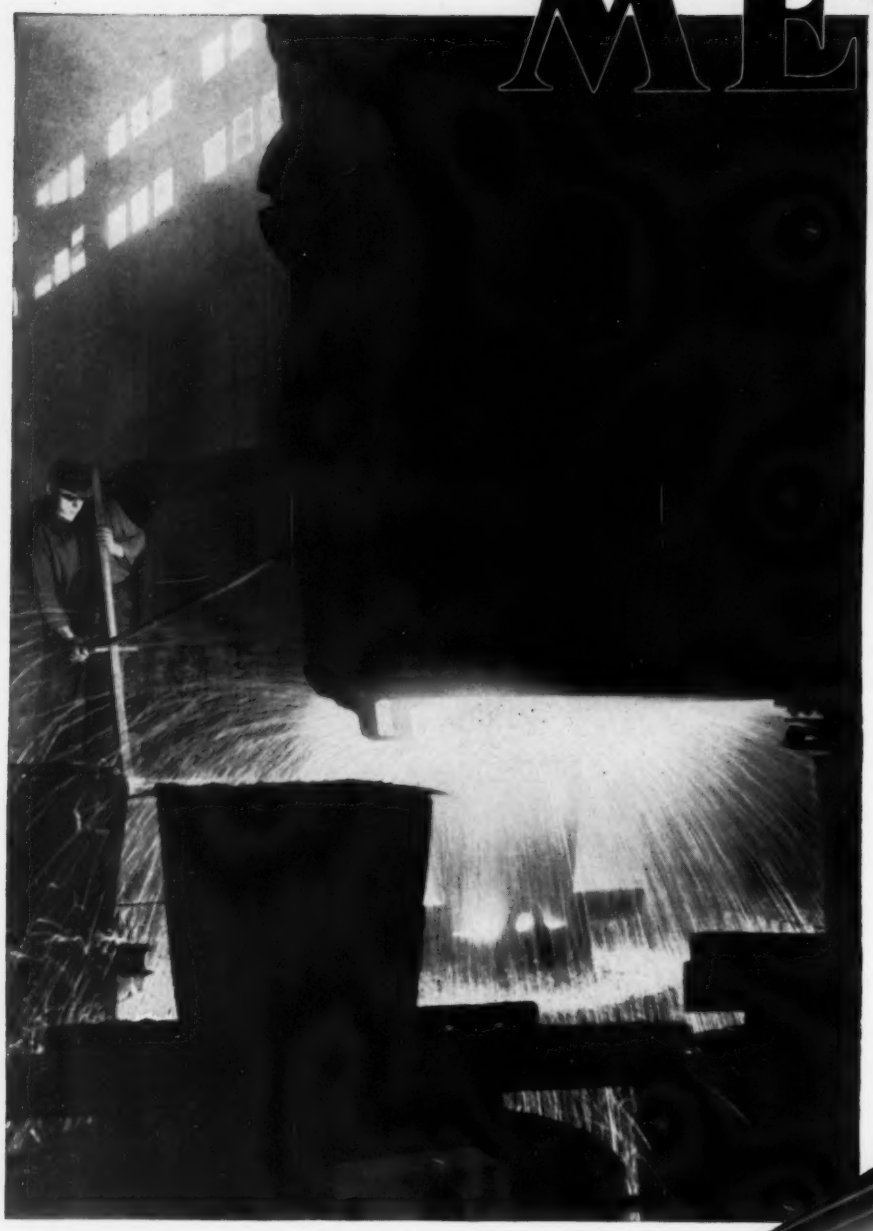
Jrl. Ad ENT-0600C(50)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS . TELEMETERS . AUTOMATIC CONTROLS . HEAT-TREATING FURNACES

MESTA



SPECIAL ALLOY CAST STEEL

BACKING-UP ROLLS

FOR FOUR HIGH HOT AND COLD STRIP MILLS

MESTA was among the first to be awarded the FLAG of the UNITED STATES BUREAU OF ORDNANCE and NAVY "E" PENNANT

MESTA MACHINE COMPANY · PITTSBURGH, PA.

THE ELECTRIC CONTROLLER & MFG. CO.
E&M
CLEVELAND, OHIO

CRANE-BRIDGE CONTROL with

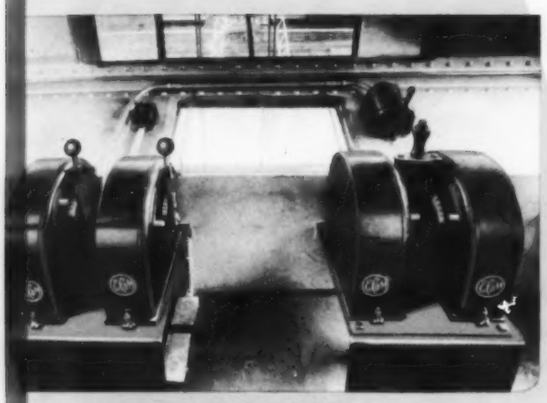
CONTROL—only a fractional part of the entire bridge cost, yet a vital factor in determining the efficiency of the bridge.

Gives you HIGH SPEED, LOW-COST PRODUCTION

Today speed with faster operation is extremely important. Equipment is called upon to handle greater and greater production.

Control is the vital part of every bridge. It means quick spotting of the bucket over hopper. It determines the number of trips per hour. It insures safe stopping at the right spot without overtravel.

EC&M gives you these features, plus many others.



Above: The operator's cab showing Type NT Master Switches. Hoist master on the right. Bridge-propelling and Trolley masters on the left.

E&M MAKES THE WORLD'S FASTEST 600 AMPERE CONTACTOR

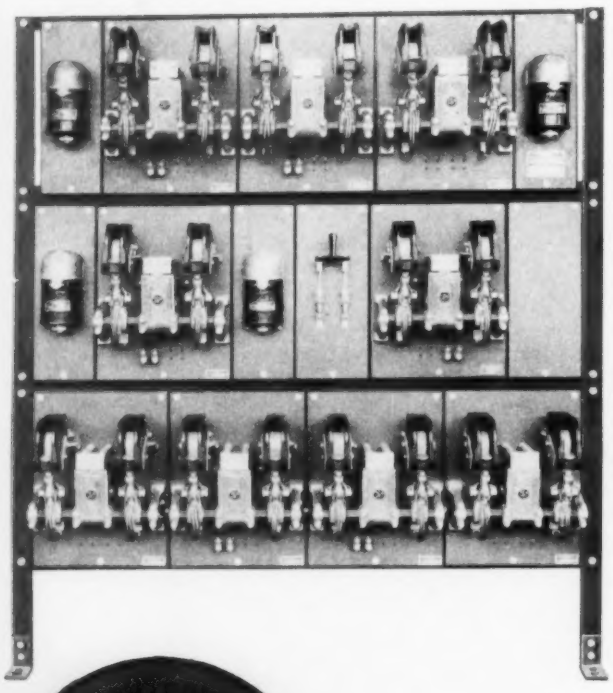
EC&M Control HAS MANY ADVANTAGES

*More **HOISTS** per **HOUR** and Less Power Consumption with the **EC&M** Wright Circuit Hoist Controller*

The EC&M Wright Circuit Bucket-hoist Controller gives increased speeds with light loads—permits lowering an empty bucket about as fast as a loaded one.

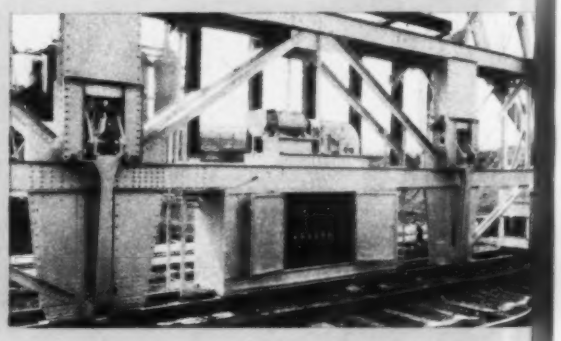
It saves on power, too. Only full load current is taken from the line on first point lowering. This means less heating on the motor—less current for commutator and contactors to handle.

Other outstanding features of the patented Wright Circuit are: Instantaneous brake release, simplified circuit giving simple, clean-cut controller, 100% safe operation and many other important advantages for increased safety and faster operation.



Propelling Controller Interlocked with Rail Clamps

EC&M's Unit-panel construction permits building the control to suit the headroom in the mounting space available. Controllers for propelling motion on this bridge are 2 decks high to permit convenient mounting in pier-leg as shown at the right.



***EC&M** Trolley Controllers Respond Quickly to Master Switch Movements*

★ The operator of a bridge with EC&M Control has many factors within his command which increase bridge efficiency. For example, the trolley controller with EC&M LINE-ARC Contactors and Time-Current Acceleration responds almost instantly to Master Switch movements. This means he can take the swing out of the bucket and spot it quickly over hopper, boat-hold, etc., to reduce the time between trips. There is no other control like EC&M LINE-ARC Contactor, Time-Current Control in this respect. Specify EC&M Crane-Bridge Control.

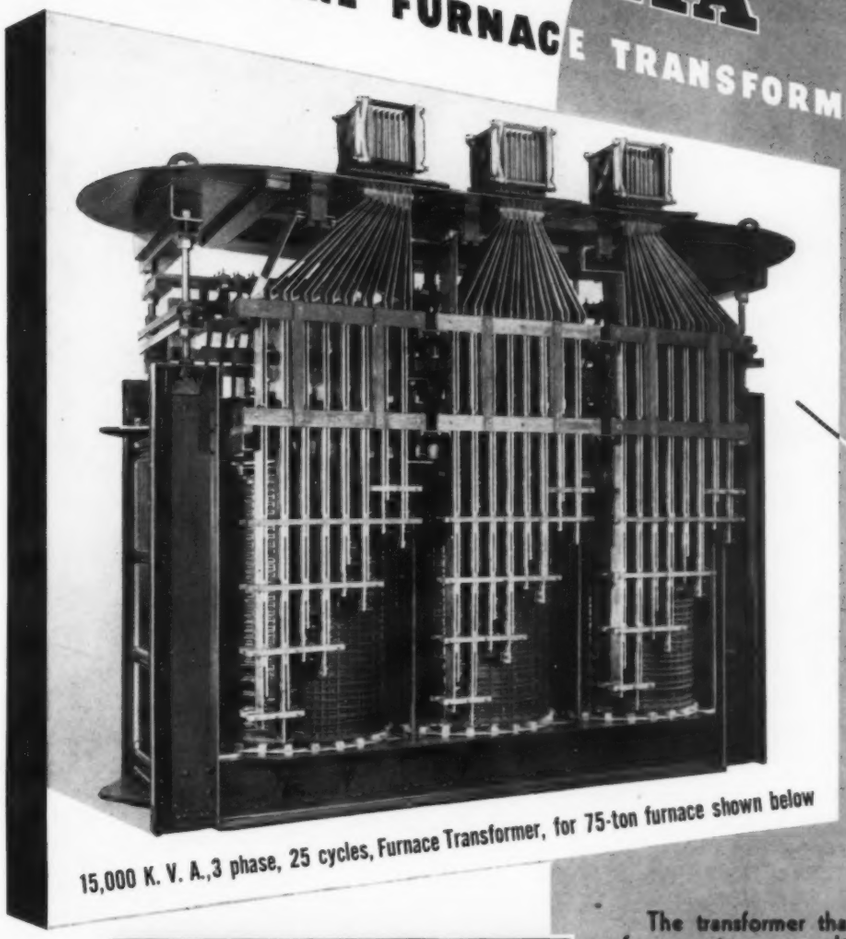
THE ELECTRIC CONTROLLER & MFG. CO.

2698 E. 79TH STREET CLEVELAND, OHIO

*Specify **EC&M** Crane-Bridge Control*

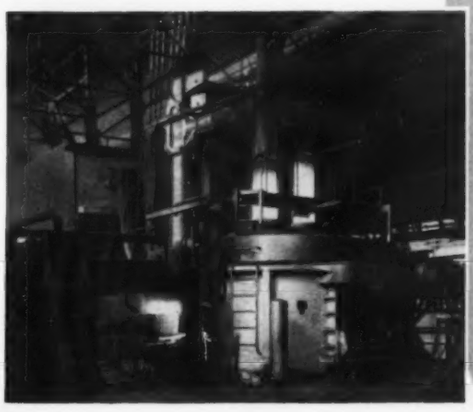
PENNSYLVANIA

CAN BUILD THE FURNACE TRANSFORMER YOU NEED



15,000 K. V. A., 3 phase, 25 cycles, Furnace Transformer, for 75-ton furnace shown below

..IN THE SHORTEST POSSIBLE TIME



The transformer that supplies power to an electric furnace is a complicated unit. Building such a transformer requires many years of experience, the highest degree of engineering skill, and technical competence at every step of manufacture.

The preference for PENNSYLVANIA FURNACE TRANSFORMERS is a fine tribute to their enviable record of successful operation in leading steel and industrial plants throughout the nation.

Due to our large production of furnace transformers we are able to carry many necessary parts in stock, such as Special Copper Bus Bars, Motor-Operated Tap Changers, Gear-Reducing Units, etc. These parts, ordinarily difficult to obtain, have a determining influence on the delivery date of transformers.

Pennsylvania is therefore equipped to start production on Furnace Transformers with a minimum of delay, and meet deliveries in the shortest possible time!

Pennsylvania TRANSFORMER COMPANY

808 RIDGE AVENUE, N. S., PITTSBURGH, PA.

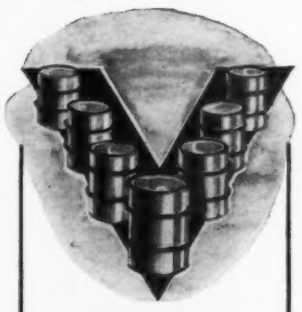
Bearings keep COOL

as a cucumber

"We gave Tide Water the toughest lubricating job in our plant, and it is doing it to our satisfaction," declares the chief engineer of this company. "It has smoothed out for us the troublesome problem of lubricating the *rubber* mill bearings.

"Never since we started using Tide Water Green Cast Grease have we had a single bearing overheated — even though we have been operating 24 hours a day, six days a week. Our greasing problem has been reduced to simply filling the cups once every eight hours."

If lubricating problems hamper sustained operation in your plant, call in a Tide Water engineer. He will study your problem and recommend the proper Tide Water lubricant "engineered to fit the job." Write today for complete details to Tide Water Associated Oil Company, 17 Battery Place, New York, N. Y.



DRUMS, DRUMS, DRUMS

War needs make it extremely important that all empty drums be returned immediately.

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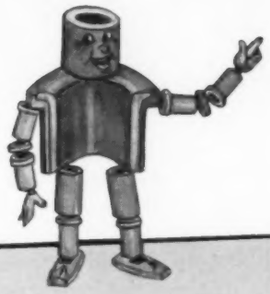
INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER INDUSTRIAL LUBRICANTS

THERE IS A COMPLETE LINE OF TYCOL LUBRICANTS SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE

Save CRITICAL METALS and Get BETTER BEARING PERFORMANCE with Reduced Cost



YEARS before the Rearmament Program, GATKE Moulded Fabric Bearings were enabling the production of *more* and *better* steel with *tremendous* savings.

In the Defense Program they have helped roll *millions* of *extra* tons with *enormous savings of power and grease.*

GATKE Bearings replace metal bearings on just about every tough rolling mill job with *better results* and *important economies.*

Of special importance to the Victory Program—they *save* POWER, *Grease, Critical Metals* and *Time.*

GATKE Bearings are moulded to finished dimensions and shipped ready to install — *no machine shop work required.*

Write for new booklet that tells results obtained under many different service conditions.

GATKE Self-Alyn Slipper Bearings last ten times longer than bronze. Eliminate scoring and wear of sockets and spades. Stop severe pounding and vibration. End deafening noises. They are moulded to finished dimensions for replacing ordinary slippers without machine shop work.

GATKE Moulded Fabric Bearings are effecting tremendous economies on all kinds of tough rolling mill jobs. They are engineered for the application and moulded to fit for installation without machine shop work in types for water lubrication, oil or grease lubrication, and some self-lubricated service. Picture shows bearing for 30 inch diameter roll neck.

Other **GATKE PRODUCTS**

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Silent Gears
Pump Valves
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Gatke NON-METALLIC MOULDED FABRIC **Bearings**

For Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes, Acid Resisting Service, and Other Tough Jobs.

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★ *"Keep the Wheels Turning"* ★

★ ON THE PRODUCTION FRONT ★

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There are many types of conveyors available today and it is most important that the correct type be used for each application. Link-Belt manufactures them all—belt, trolley screw, Bulk-Flo, chain, apron, flight, bucket, etc.—all products of over a half century of experience in the engineering and manufacturing of equipment of this kind. A nation-wide staff of engineers is at your service.

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The maintenance of your mechanical power transmission equipment, in A-1 running order, is all important to maximum production efficiency. Link-Belt transmission experts, with a complete line of mounted and unmounted ball and roller and babbitted bearing units, clutches, couplings, collars, sprockets, shafting, etc., are ready and anxious to assist you.

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If you wish to cut costs and improve your drying operations, eliminate obsolete methods, save on heat and maintenance, you will be interested in the unique features of the Roto-Louvre dryer-cooler as described in special catalog and engineering data book No. 1911. It contains valuable information on the subject of drying and cooling. Send for a copy.

SHOVEL-CRANE-DRAGLINE SERVICE

Link-Belt Speeder Corp. offers a complete service to those engaged in essential construction, excavation, erection and other work, calling for the use of this type of equipment. A complete line ranging from ⅜ to 3 yd. capacity and a country wide engineering and service personnel is available to serve you.

LINK-BELT V FOR UNITY FOR VICTORY

● With industry on the offensive, all goes well only as long as your machine tools, material handling and preparation, mechanical transmission and power equipment are holding up . . . for the Nation's life depends on the productivity of this plant equipment.

Constant vigilance and an extra measure of lubrication, cleaning and adjustment will ward off breakdowns — conserve replacement parts — save priceless production time.

●

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Slipping drives are a menace to machine efficiency. Link-Belt chain drives (silent, roller, steel, malleable, and other types) cannot slip . . . . engagement of chain and sprockets is positive . . . . no frictional contacts . . . . no lost R.P.M. . . . the rated capacity of the driven machine is maintained at all times. Let a Link-Belt positive drive specialist help solve your drive problems.

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Top performance requires the exact type and size unit that will fit your application. Making three types of gear reduction units—herringbone, worm and motorized—and two types of variable speed units—the P.I.V. Gear and V.R.D. units—Link-Belt can and will give you authoritative and unbiased counsel. Send for helpful engineering data books.

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Whether your problem is complex or simple, be sure and call on Link-Belt for help. Years of experience in the application and manufacture of a complete line of all types of screens—vibrating, shaking, rotary, conical, cylindrical, etc.—assure successful installations. Send for literature on any or all types.

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Getting coal to the fire and ashes away presents one of today's most fertile sources for conservation and increasing efficiency in power plant operation. A special Link-Belt Book, No. 1510, points the way with ideas and suggestions, and information on the proper application of the various types of mechanical handling equipment. Send for it today.

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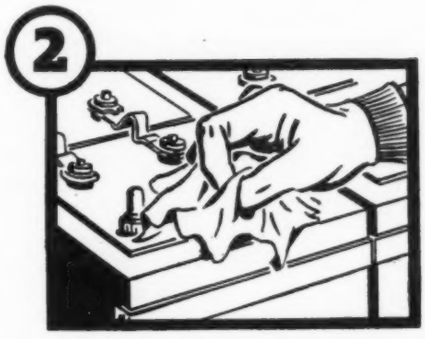
LET'S GO! U.S.A. · KEEP 'EM FLYING!

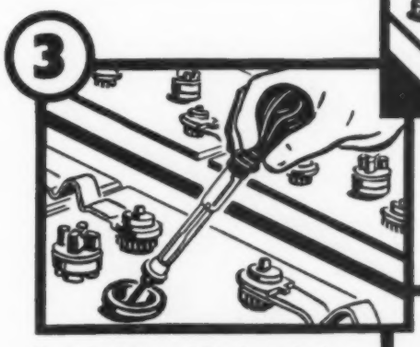
SAVE TO WIN

EVERY storage battery is a war weapon, containing metals vital to our fighting men. You hold these metals in a sacred trust. It's your duty to squeeze from them every ounce of use . . . by following simple rules for battery conservation.

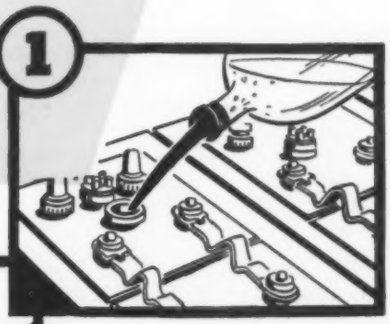
HERE'S HOW TO MAKE YOUR BATTERIES LAST!*



Keep the top of the battery and battery container clean and dry at all times. This will assure maximum protection of the inner-workings.



Keep the battery fully charged—but avoid excessive overcharge. There's always a right-way to do any job, and a storage battery will last longer when charged at its proper voltage.



Keep adding approved water at regular intervals. Most kinds of local water are safe in an Exide Battery. Ask us if yours is safe.

Keep records of water additions, voltage and gravity readings. Don't trust your memory. Write down a complete record of your battery's life history. Compare readings. Know what's happening!

Exide IRONCLAD BATTERIES

*** If you wish more detailed information, or have a special battery problem, don't hesitate to write to Exide. We want you to get the long-life built into every Exide Battery. Ask for booklet Form 1982.**

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
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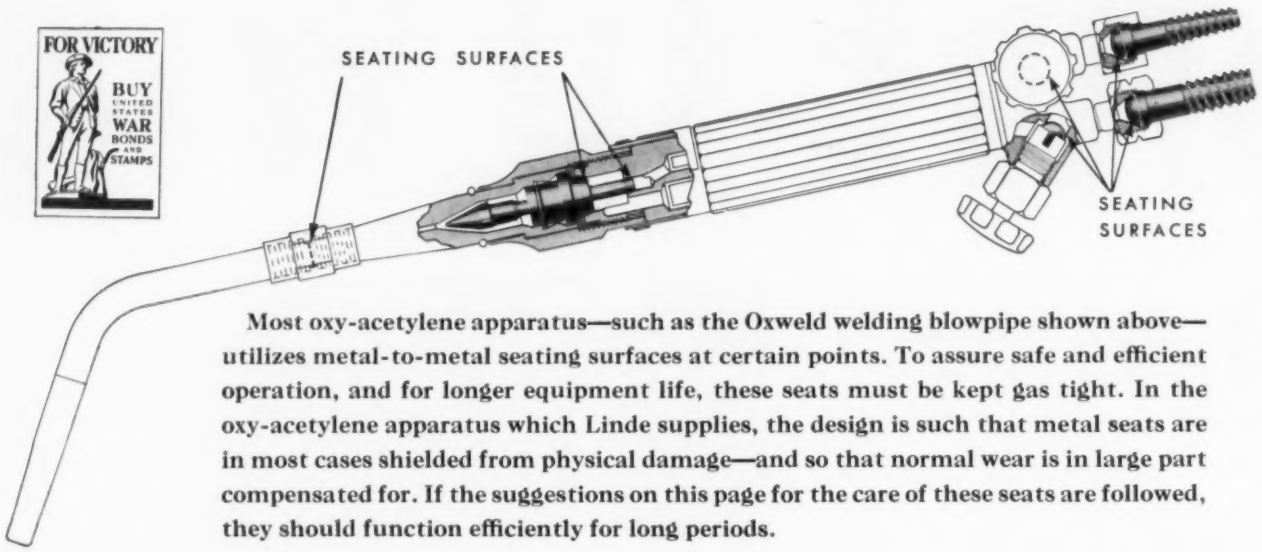
For Efficient Operation and Longer Life

Take Care of Metal-to-Metal Seats



Most oxy-acetylene apparatus—such as the Oxweld welding blowpipe shown above—utilizes metal-to-metal seating surfaces at certain points. To assure safe and efficient operation, and for longer equipment life, these seats must be kept gas tight. In the oxy-acetylene apparatus which Linde supplies, the design is such that metal seats are in most cases shielded from physical damage—and so that normal wear is in large part compensated for. If the suggestions on this page for the care of these seats are followed, they should function efficiently for long periods.

What Happens When Seats Leak

Flame Characteristics **may be seriously affected when a blowpipe seat leaks because of mars, dents, or scratches—or because it has not been correctly tightened. This makes good work difficult to perform.**

Inefficient Operation **results from leaky seats and may cause flashbacks which will deposit carbon on seating surfaces throughout the blowpipe. Such deposits, if not removed immediately, will become ground in and heavily encrusted. This condition will cause increased leakage which in turn will bring about still further inefficiency.**

Increased Costs **result from working with damaged equipment. Never use oxy-acetylene equipment which is in need of repair. When parts with metal seats which are in good condition are assembled to dirty or damaged seats, the result is apt to be that the good seats are also ruined. Take precautions against small leaks which may present a fire hazard.**

How to Prevent Damage to Seats

Keep Them Clean**—when dirt or grit is present on metal seating surfaces, scratches and mars may result from tightening up the connection, and a leaky seat will result. For this reason, frequently wipe all metal seats clean.**

If a Flashback Occurs, **it usually is because of improper handling or incorrect pressures. However, it may be due to a leaky seat. Before relighting the blowpipe, examine *all* seating surfaces and wipe away with a clean cloth any carbon deposits left by the flashback. Then make sure all seating connections are tight. If the blowpipe still flashes back, the cause should be determined and corrected before using the apparatus further.**

Always use a Wrench **in making connections where a nut is provided for this purpose. Never tighten a welding head onto a blowpipe by twisting the stem. This will usually fail to make a gas tight connection, and will invariably cause excessive wear or damage to the seats.**

Blow Out Cylinder Valves **before connecting a regulator by opening them for an instant to blow out dirt and grit. If you do not, any dirt or grit present will damage your regulator inlet nipple seat, because cylinder valve seats are the harder of the two. Always read instruction books.**

Instruction Books Available

• Duplicate copies of the instruction books packed with oxy-acetylene apparatus supplied by Linde, will be sent without charge upon request. Be sure to specify the type of apparatus you have.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

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The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks of Units of Union Carbide and Carbon Corporation.

IS BILLET CHIPPING YOUR BOTTLENECK ?

Chipping time ratio on this 8½" x 10" billet of S.A.E. 1450 Steel was 49 to 1. Billeteer cleaned light portion, at right, in ⅛ time required to hand-chip dark end, at left.

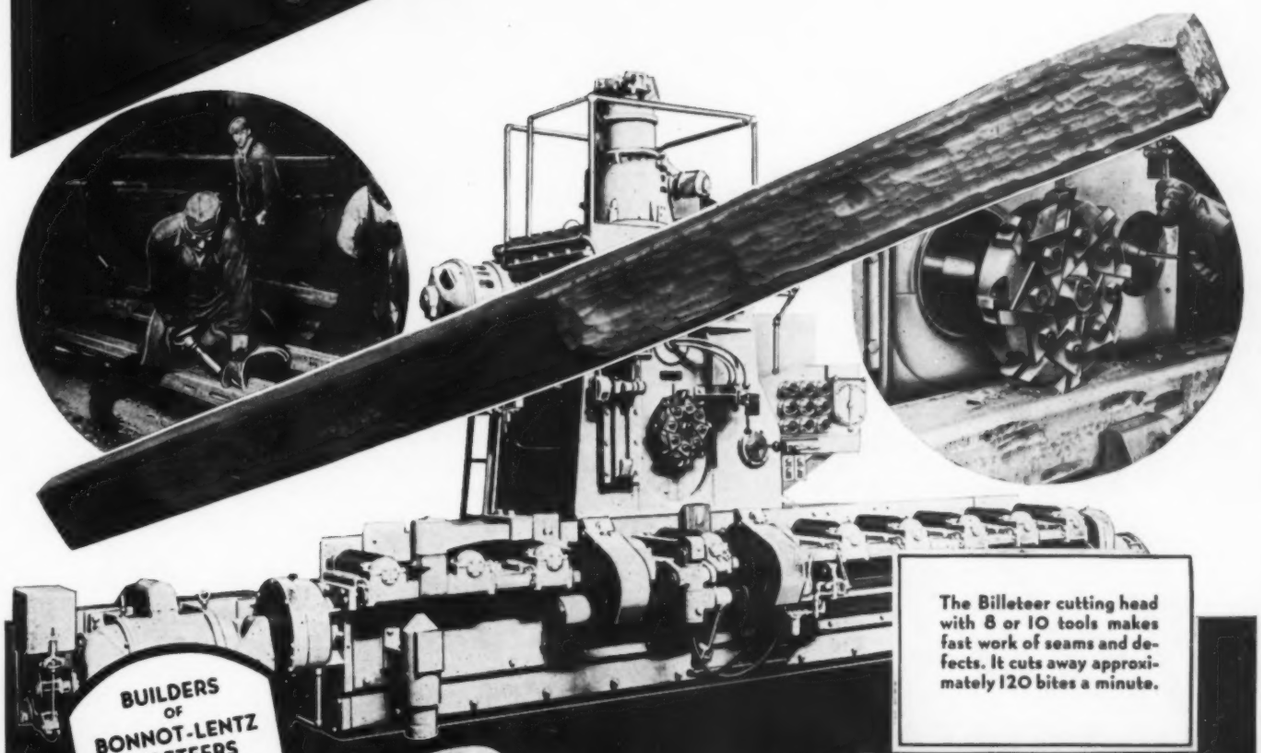
Do you have trouble maintaining an adequate force of billet chippers? Are they unable to keep up with your full billet production?

If billets jam up in your chipping department, you should get the facts on the

BILLETEER

This complete billet chipping unit answers the "call to production" by working 24 hours a day if necessary, and asks no quarter! Turns out thoroughly cleaned billets in record-shattering time (10 to 20 billets while the average chipper is doing one by hand). All operations under finger-tip power control of a single operator.

Billeteers carry a very high priority rating. The demand for this machine prevents our keeping them in stock — so place your order NOW for earliest future delivery.



The Billeteer cutting head with 8 or 10 tools makes fast work of seams and defects. It cuts away approximately 120 bites a minute.

BUILDERS OF BONNOT-LENTZ BILLETEERS ALSO CRUSHING PULVERIZING AND MIXING EQUIPMENT

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
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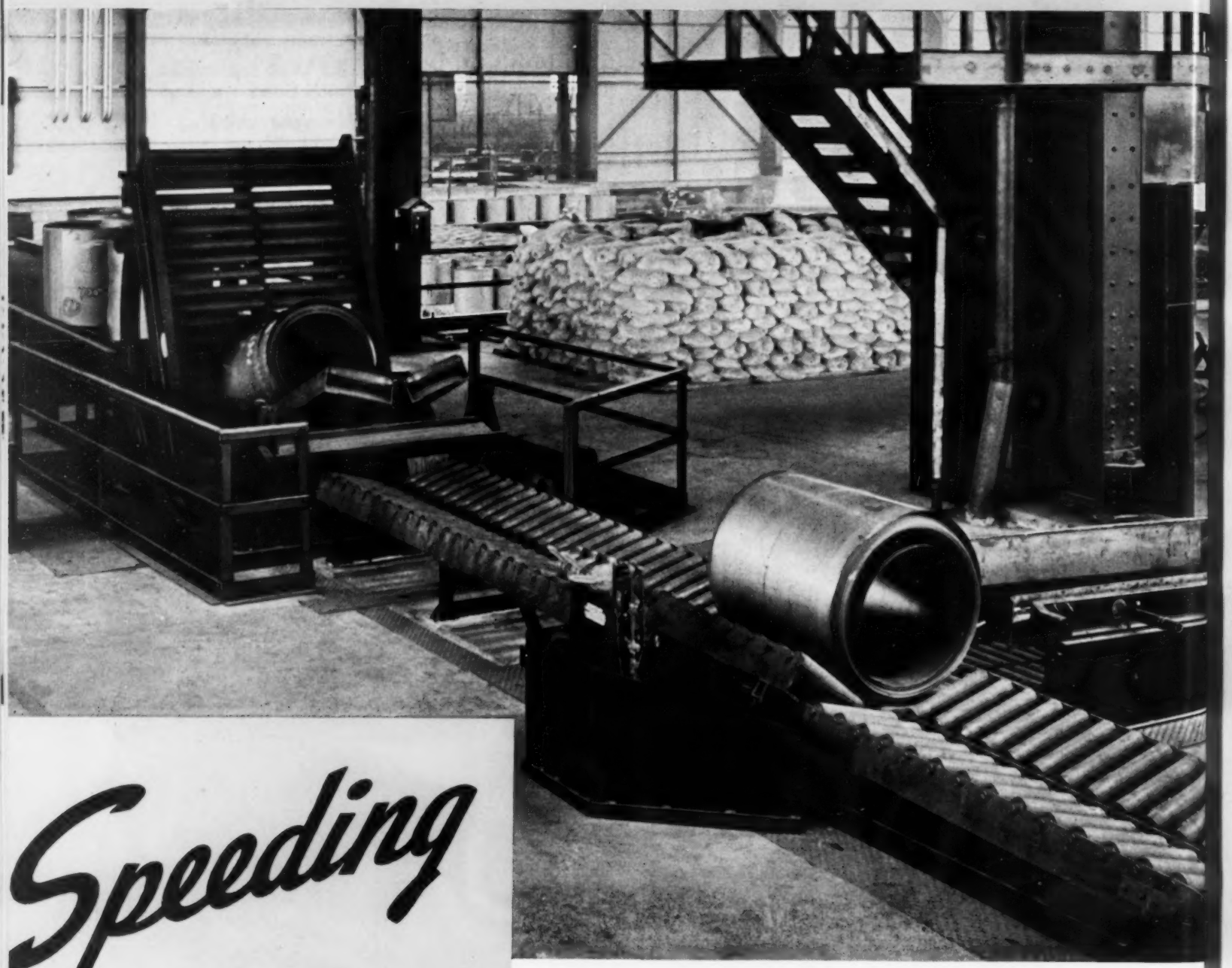
MATHEWS CONVEYERS FOR MECHANIZED HANDLING

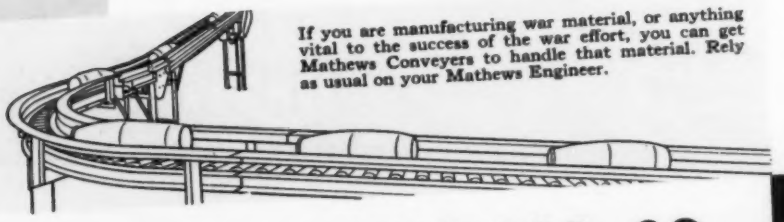


Speeding THE TOOLS OF Victory

● TIME WAS NEVER MORE PRECIOUS than in this national emergency. Every step that can be saved . . . every unnecessary motion that can be eliminated . . . every ounce of energy that can be conserved helps to speed the tools of victory.

Keeping munitions, materials, and machinery supplies moving faster and with less worker fatigue is the function of Mathews Conveyer Systems.

Mathews engineers have helped hundreds of manufacturers of war material speed up production schedules with no increase in man-and-machine hours!



If you are manufacturing war material, or anything vital to the success of the war effort, you can get Mathews Conveyers to handle that material. Rely as usual on your Mathews Engineer.

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IRON AND STEEL ENGINEER

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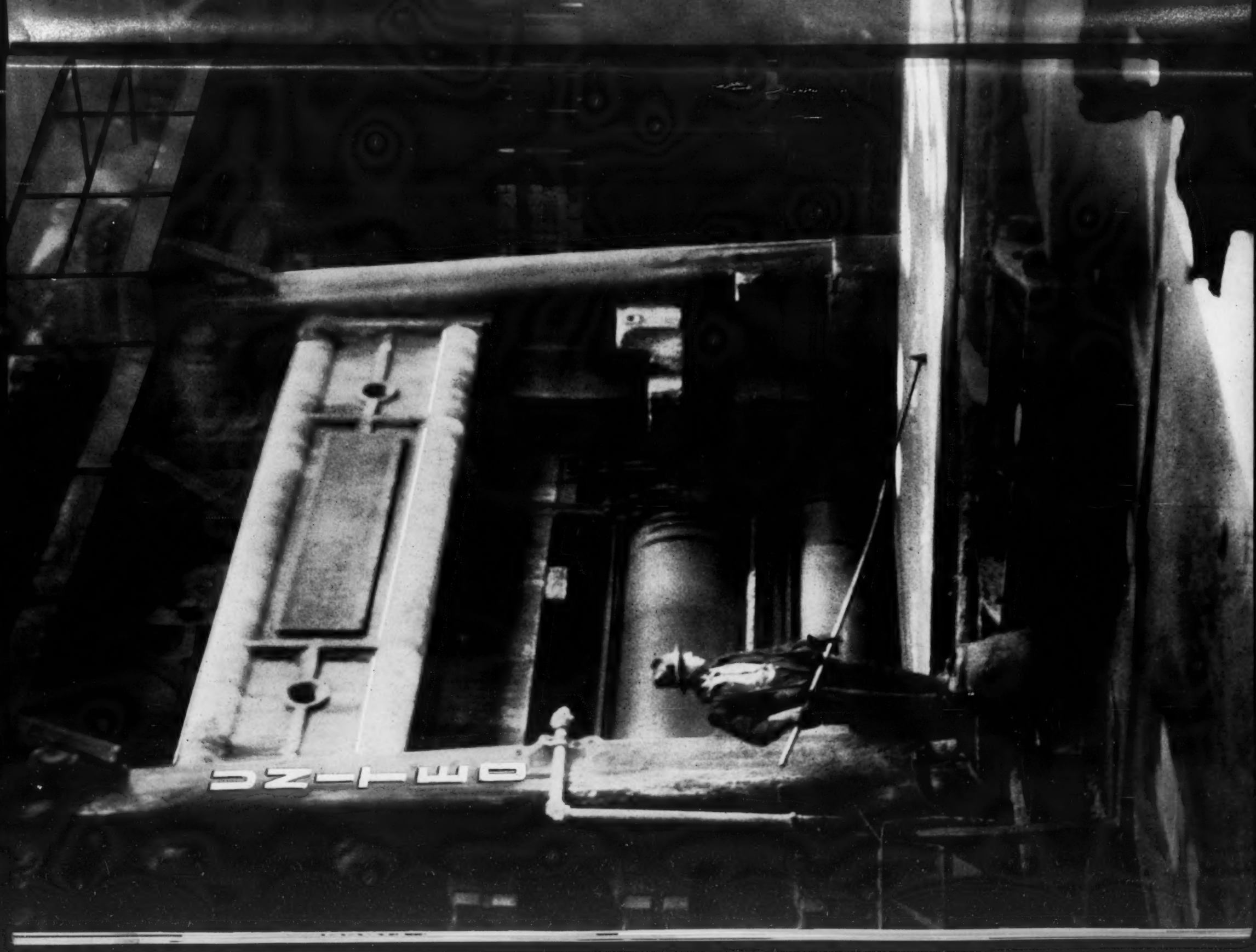

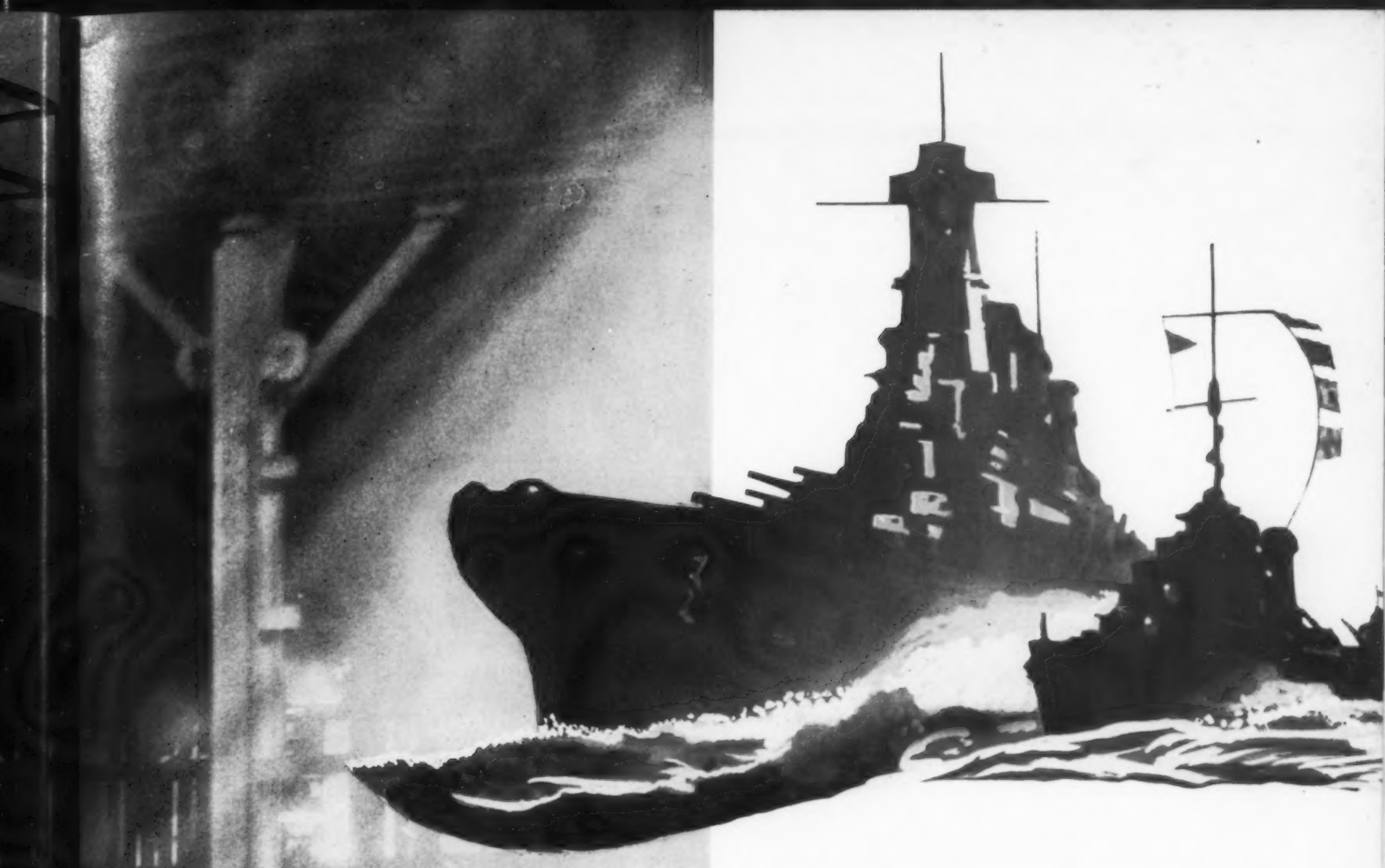

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PITTSBURGH, PENNSYLVANIA

SUBSTITUTE COATINGS *for*

▲ IN ALL probability, no other finished product lends itself generally to such wide applications of use or affects the lives of large groups of the civilized world to the considerable degree as does tin plate. This may appear to be a rather strong statement, but upon more sober consideration of what the probable effect would be if there were no tin plate, we can well realize the benefits, for example, in the container field.

In tin plate, we have a material in which is combined the favored qualities of two of the most useful metals, steel and tin. Under such circumstance, it is only natural that there should be available from such a product a broad application of usage, combining the strength of the steel and the corrosion resistance of the tin as a protective coating. The favored combination of these characteristics would naturally establish it as a possibility for an extremely wide range of use in fields of application where the black sheet was subject to corrosion and the protection afforded by tin overcomes any normal corrosion hazard. Earlier, of all processes available for surface protection, including painting and other surface treatments, it developed that the use of tin as a surface coating was the most useful, economical, and reliable. Such a coating was found to be not only corrosion resistant for most general purposes, but was easily soldered and lubrication from the tin coating promoted better drawing and forming properties. From the nature of the physical properties available in the product, it was relatively easy to roll the sheets into cylindrical shapes, which were the basis for can manufacturing. The cylindrical shape, besides being easily fabricated, was the most economical, considering the value of the tin plate material, to enclose a given volume, and also provided a strong and rigid container.

The general interest in the use of tin plate is in the container field — processed sanitary cans. General line cans — covering a tremendous field of use, ranging from some processed packs to dry pack materials, also paints, oils, and liquids — with the closure market of crown caps, screw caps, and the large varieties available, all commanding large tonnages.

While the tonnages consumed in these fields has increased by leaps and bounds, the improvements in the physical chemistry of steel making, in methods of rolling and processing, and in the application of superior tin coatings have each contributed their share toward producing a quality of tin plate of such superior characteristics that the consuming markets developed new uses and expanded the use in the established markets. Earlier, with the steel making practices as established at that time, the fine art of control of contaminants and knowledge of their effect on many products was not established or anticipated in the degree to which it is practiced today. Steel analysis for tin plate was based, not so much on any standard of quality, as on the fact that considerable amounts of phosphorous and silicon and other impurities were present, which were necessary to prevent sheets from welding together under the conditions present in the hot pack rolling method.

With the advent of the wide strip mill and cold reduction mills rolling to extremely thin tin plate gauges, it was observed that the removal of certain elements improved rolling properties, provided extreme deep drawing performance, and also improved the overall corrosion resistance of tin plate.

By reason of the establishing of higher standards for tin plate, new standards were established for sanitary can packs, and crown cap use among others. New markets and new standards necessitated improvements in the tin coating and tin coating practices were subject to investigation and a much higher standard of quality and uniformity was produced than ever was anticipated by the earlier producers. The earlier producers had manufactured a sheet which met the standards in vogue during their particular period, but relied on extremely heavy tin coatings to supply the corrosion resistance where any extreme requirement was present. During recent years, the cold reduced base sheet was more corrosion resistant and, with the improvements in tin coating practice, the natural service life of sanitary cans in particular and all products in general was greatly increased. Many product applications have benefited to the extent of covering wider markets than their earlier experience would ever have indicated.

Earlier standards of quality were pretty well established with a sort of "let well enough alone" attitude. While certain finish variations were available in tin mill black sheet quality, the tin plate, during the days of the hot rolled product was coke tin plate and any unusual requirements in corrosion resistance or drawing quality necessitated an added quality of coating — in most cases requiring a charcoal coating. The introduction of cold reduced product improved the quality of corrosion resistance and also the drawing quality, so that many products previously requiring special coatings were able to meet the required standards in the ordinary coating weights. The facility with which cold reduced tin plate was fabricated assisted the fabricator in developing multiple die drawing operations and also in increasing the speed of the fabricating processes. The combined result was that finished product costs introduced manufacturing advantages, which, in turn, created new markets and so increased tonnage requirements. This condition was apparent during the last seven or eight

TIN PLATE

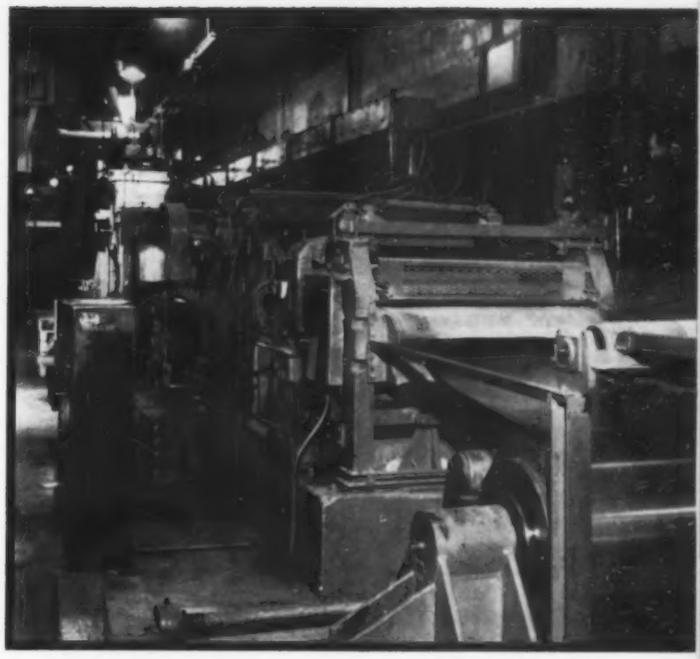
By C. E. Brown

Metallurgical Engineer

JONES AND LAUGHLIN STEEL CORPORATION

Aliquippa, Pennsylvania

Presented before A. I. S. E.
PITTSBURGH AND CHICAGO DISTRICT SECTIONS



A considerable number of electrolytic pickling lines are under construction, affording a source of tinplate with greatly reduced tin consumption.

years; for, when tonnage requirements in some other lines were at a minimum, the tonnages of tin plate produced remained relatively constant or lost little ground; and, when the other products regained their earlier tonnage position, the tin plate tonnage assumed tremendous values.

The situation of the present day has now developed a condition where tin plate is subjected to meeting a problem which has developed on a front somewhat removed from the economics of ordinary product consumption. Certain competitive factors, such as glass, paper, and fiber materials, have been in the picture throughout the industrial cycle. The current condition is serious, not from a competitive angle, but due to factors affecting the supply of metallic tin used in coating the tin plate. The effect of control of the sources of tin by unfriendly groups, as evidenced by Japanese control of the tin producing areas in the Malay Straits, is to look to new sources for tin and materials which can relieve the burden during the interim. This is our problem.

By no means can we conceive that these substitutes and new materials will carry the whole burden until new tin sources are producing adequate tonnage. Already, certain restrictions are in effect on the uses to which tin may be applied. Other restrictions will follow. Sanitary cans for packing of such foodstuffs as are not suited to other means of packaging will be given favorable consideration by those in charge of tin rationing.

Other features of our problem hinge on certain decisions. The allocation of steel as needed to meet military and civilian defense needs will determine at what proportion of capacity the cold reduction mills will continue to produce. We will assume that some proportion of the tonnage will be tin coated; the remainder, of necessity, must be protected by materials other than tin. It is to these possibilities that we now turn.

In order to evaluate the character of surface protection required, we should understand the function provided by tin on tin plate coverage. Tin coating generally serves several purposes:

1. It provides protection on the outside of the container against rusting in storage.
2. It provides protection on the inside of the can from corrosion by the contents.
3. It has the particularly favorable property, under most conditions, of maintaining the contents in their original state of clarity and natural flavor.
4. It permits the necessary soldering at extremely high production rates.

Our concept of tin plate has been based upon materials coated in hot dip pots. Metallic substitutes for the hot dipped product appear to be quite limited, while electrolytic tin plate in a variety of coating weights lighter than the usual hot dipped tin plate have been looked at experimentally. Hot dipped terne coatings, while mostly lead, require a certain amount of tin, and our problem is concerned with the conservation of tin and also of lead. Then, too, for a great many purposes, terne plate is not particularly applicable, as, for example, for foodstuffs, pharmaceuticals, and cosmetics. At the moment, there appears to be no other suitable application in hot dipped coatings. Although certain lead alloys have been considered, their relative status is no more favorable than terne plate.

The other alternative in metallic coatings is by means of electrodeposition. For example, in the electrodeposition of tin, several systems have been proposed, and the products of each have their advantages. Various coating weights have been applied, and the properties and applications for which they appear best suited are being investigated. In any of these investigational projects, the amount of information available thus far is very limited as compared to the general knowledge of the

application and usage of hot dipped tin plate. It is hardly to be expected, at such an early date, that a too positive background of experience should be generally available.

We understand that other electrolytic coatings are being looked at generally. Some alloys are proposed as possibilities for electrodeposition, but there is very little general knowledge regarding the types and general suitability.

An electrogalvanized product might be suitable for some purposes in non-food containers, but zinc is relatively scarce and this coating does not lend itself too well to many purposes, and has, as well, poor soldering properties.

Silver has been proposed as an electrodeposited coating, but the cost is relatively high for a great many containers as compared to tin plate cost. However, it is probable that some type of containers will justify the use of silver in packing certain corrosive products.

Corronizing has been proposed as a corrosion resistant alloy coating which appears to have merit for a number of purposes. The corronized coating is one consisting of relatively thin layers of metals and alloys having corrosion resistant properties. We understand it consists in applying a composite coating of nickel and zinc or nickel and tin or other ferrous or non-ferrous combinations. The coatings are generally heated to a temperature and cycle to obtain the preferred condition of coating. The difficulty during the present emergency is with many processes, that nickel, zinc, aluminum or tin are all limited in their availability.

The other alternatives consist in either the application of a protective or passivating film having a metallic characteristic or by coverage with lacquers or enamels.

Black plate, not having a metallic coating, has been supplied to the trade under a variety of conditions. Some plate has been shipped, in the past, with no protection in transit other than the wrapping around the unit. This is quite hazardous if a rustproof sheet is demanded as any incipient rust occuring will continue to grow under the lacquer or enamel coating. This necessitates sizing or lacquering the sheet immediately, as any storage is usually impractical, due to rust formation.

The oiling of plate usually provides only a nominal protection until decorated. Various oil films have been proposed. Wool oil, in different forms, has had some application, but in films light enough to permit decorating or lacquering without subsequent removal, only a limited degree of protection has been possible. Considerable work has been done on oil films of a water soluble type and with those requiring a petroleum solvent, which is evaporated leaving the oil as a thin surface film. This kind of coverage provides a fair degree of protection under lacquered or decorated films, which are not subject to process conditions of the character required for sanitary can packs. Some oil films observed indicate an improvement in the amount of protection and also of lacquer adhesion, both of which are important parts of the problem. So far, certain oil films have shown an improvement for some applications to dry packs and general line cans, which in any event would be lithographed.

Lithographing or lacquering supplies only a nominal amount of surface protection. It can provide an attractive surface coverage, but if the plate has been exposed to conditions of excessive humidity or sweating as a result of poor storage conditions, incipient rust pitting will quickly develop. This form of corrosion originates as numerous small pinpoints, from which it grows rapidly. In part, the rate of growth depends on temperature and humidity. Small specks or pinpoints may be present and after coating, particularly with unpigmented materials, develop into a distinctly unattractive appearance. Although cases have been observed, where colored decorations have been applied successfully over light rust spots, this is hazardous and under usual conditions would not be tolerated.

There are indications that development work on the part of the paint and varnish groups has improved the protection in some newer coatings. Some claim good results from certain size coatings; others use combinations of the size coat and the finish coating system. These all require coating or lithographing equipment and elaborate baking ovens with sheet conveying mechanism. A size is a prime coat on the base sheet, which is claimed to improve adhesion or rust protection, or both. Most sheets after sizing and baking have a top coat applied and baked, or might have three or four, or even more, applied, each being usually baked and recoated for each individual coating. Most of the clear or gold lacquers, as applied to black sheets, are suitable only for general line cans or dry pack containers, although some claims are made regarding sanitary lacquers for use on black plate in sanitary cans.

While the work on enameling of black plate has shown some promise so far, it is not the final answer on coating of plain black plate for processed cans. There are three general problems associated with the use of black plate:

1. The protection must provide rust protection before coating.
2. It must eliminate underfilm corrosion.
3. The enamel adhesion must be good.

1. Rust protection is required in transit or during storage preceding lithographing.

2. Underfilm corrosion has no relation to the usual type of rust observed on sheets, as it is of a distinctly different pattern and occurs only after the sheet has been coated and baked. Generally, three to six weeks are necessary to develop it as high humidity and temperature accelerate the condition quite rapidly.

3. Lacquer adhesion is necessary for good protection. Poor adhesion usually results in poor service life. The problem is rather complex in that certain treatments on sheets, providing good adhesion and no underfilm corrosion, provide poor rust protection; while others that provide rust protection and are free of underfilm corrosion have poor adhesion. The answer, apparently, is not with unoiled black plate or oiled black plate which is lacquered afterwards.

Proposals for the application of surface films have narrowed down to several treatments. Bonderizing and phosphoric acid treatment have provided the best results, although at the present time tests on bonderized films have appeared to have better possibility for application to sanitary can requirements. The bonderized film alone is not corrosion resistant: it must be lacquered. It appears to meet the requirements of rust resistance (temporary), eliminates underfilm corrosion, and provides good lacquer adhesion. Elaborate equip-

ment is required for bonderizing, and it is probable that its use will expand. The cost of application is considerable and, in addition, it must be lacquered on both sides.

A bonderized finish cannot be soldered, has limited fabricating properties, and is proposed for packing products with mildly corrosive properties. It appears limited to use as end stock, which alone consumes a considerable tonnage.

Phosphoric acid surface treatment is stated to be less satisfactory than bonderizing. Other surface films may be produced by chemical treatment, in combinations, for example, of phosphates, chromates, or borates. The films resulting from these treatments are either ineffective as concerns rust prevention or lack good lacquer adhesion.

Oxide films, including those produced chemically, provide only nominal protection, must be oiled, and even then do not meet all the requirements.

The limited choices available, therefore, consist of oiled and lacquered black plate, perhaps with a size coating; or a bonderized finish; or an unoiled black sheet.

Whether the sheet is delivered as an unoiled sheet or oiled will be to the customer's specification, which might require a heavy film and be prebaked before lacquering. These are problems which vary according to local conditions. In any event, the most satisfactory oil film would lend itself only for temporary protection, requiring eventually a lacquer or some other finish, as a top coat.

No other metal coating being available but tin and terne, the possibility of using stainless or a clad steel occurs; but the particular elements providing the corrosion resistant features are not available, being required urgently for war purposes.

The advantage of using enameled sheet of the vitreous type has been suggested but the temperature used to fuse the coatings and handling problems involved do not indicate much possibility along this line.

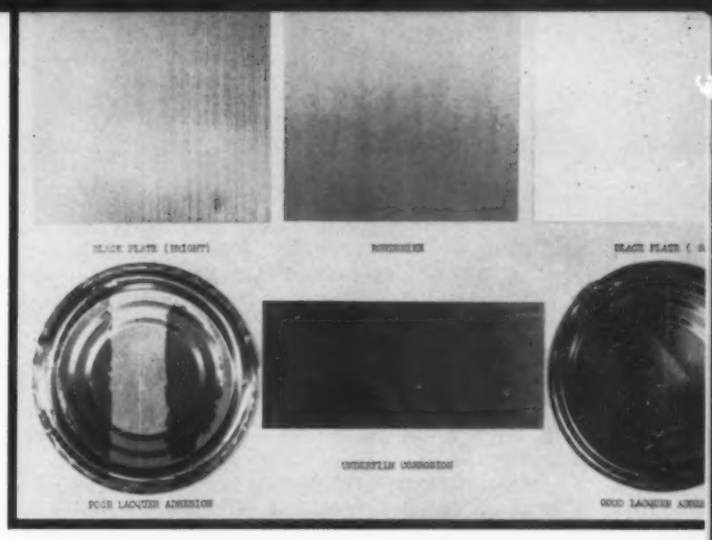
The tremendous quantities of cans to be handled after fabrication indicates that the can fabricating machinery, as set up at present, must be used to the maximum capacity, when one considers the packs proposed for 1942, as compared to 1941.

	1941	1942
Tomatoes	29,000,000 cases	44,000,000 cases
Snap beans	10,000,000 cases	14,000,000 cases
Peas	28,000,000 cases	42,000,000 cases
Corn	23,000,000 cases	25,000,000 cases

These, of course, are only a portion of the production of the canning industry and give an idea of the problems ahead in the current year.

While certain containers, such as glass, paper, fiber, and some latex and cellulose containers have expanded their use, each has some unfavorable feature by which their advantage in the packaging field is subordinated to the tin plate container. For example, glass is subject to certain limitations, among others being weight and exposure of the product packed to light.

These applications all have their particular problems, and with the amount of metal coated plate to be available, either as hot dipped or electrolytic tin plate and as terne plate, the remaining portions as bonderized or as an unoiled or oiled black plate, will require an extreme effort from the paint and varnish technicians to provide suitable coating protection.



This illustration shows some plate finishes as well as certain defects in coating.

It is generally agreed that the substitutes, as lacquers, etc., will not, in all cases, perform on a parity with tin coating protection; but, that some reduced standard must be accepted. This will result in a shorter service life for some products; in other cases, with possible visual evidence of corrosion, which must be accepted. It is possible greater attention must be paid to moving of stock, in order that the older materials are disposed of without too great a delay.

Actually, the future is less gloomy than would seem, as indicated by the limited substitutions for tin coating. The diversion and substitution of tin from other uses, as well as the use of black sheets on items earlier required in tin plate, has reduced the potential demand for tin. The lacquer and enamel producers have improved certain features of their products, and this, in combination with the efforts of the sheet producer and the lithographer, must of necessity improve the quality of the container. Added attention to these features from all concerned will improve the situation. The fact is that there is no actual substitute for tin as protective coating in the tin container field and that the alternatives provide only a method of protection with a lower standard of service performance than that to which we have been accustomed in the past.

DISCUSSION

PRESENTED BY

E. W. HOPPER, Superintendent, Tin Mill, Crucible Steel Company, Midland, Pennsylvania

CHARLES H. MANION, Vice President, Follansbee Steel Corporation, Follansbee, West Virginia

JOHN M. READ, Republic Steel Corporation, Warren, Ohio

E. T. LORIG, Design Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

(Continued on next page)

(Continued from preceding page)

C. E. BROWN, Metallurgical Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

W. J. HENNESSY, Technical Service, Pennsylvania Sales Manufacturing Company, Pittsburgh, Pennsylvania

J. A. HELBLING, Assistant Chief Metallurgist, Republic Steel Corporation, Warren, Ohio

BERNARD RAHILLY, Special Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

P. N. BOSSART, Research Engineer, Union Switch and Signal Company, Swissvale, Pennsylvania

W. H. MANDY, Lubrication Engineer, The Texas Company, Pittsburgh, Pennsylvania

FRANK E. JACQUES, District Representative, G. S. Rogers and Company, Pittsburgh, Pennsylvania

A. J. BERDIS, Chief Engineer, Irvin Works, Carnegie-Illinois Steel Corporation, Dravosburg, Pennsylvania

J. F. EDNIE, Metallurgical Engineer, American Smelting and Refining Company, Pittsburgh, Pennsylvania

L. I. FIELD, Engineering Department, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

GEORGE H. RENDELL, Electrical Engineer, Carnegie-Illinois Steel Corporation, Gary, Indiana

W. G. CRANE, Inland Steel Company, East Chicago, Indiana

LESLIE BERNICK, Inland Steel Company, East Chicago, Indiana

A. H. BRISSE, Carnegie-Illinois Steel Corporation, Gary, Indiana

E. W. HOPPER: Probably there are not many people who realize that the Crucible Steel Company has been producing commercial electrolytic tin plate since July, 1937. We have not been trying to sell any process or equipment. We have not been interested in any other substitutes for tin plate. We believe there is a definite value in a lighter coating and know there has been considerable difficulty in getting good light weight coatings. Our interests are definitely in producing electrolytically a coating that will afford better protection. We see no reason why we cannot reduce the coating weight to the present half-pound and even below that, and at the same time get the soldering effects that are necessary on the body making lines. I believe the thoughts expressed by Mr. Brown are good, and agree especially with his remarks about the use of bonderized plate and the necessity for lacquering.

CHAS. H. MANION: Mr. Brown's paper represents a great deal of abstract research and much investigation into many installations. I wonder if in these, as in some other problems, we engineers and metallurgists are not a little too narrow in our views, confining our examination to only one tree instead of looking the whole forest over. It is evident there are two problems involved in the present shortage of tin. One is our embarrassing position in the present emergency — but there is a greater problem. This problem concerns not only the tin plate man, but all steel men back of it. It is just as interesting to the man making the steel as to the men making the tinned product. Not only is tin coating in jeopardy, but the use of that steel for which we have accepted tin plate as a basic outlet is also in question. Substitutes remain purely substitutes so long as there is a desire for the general article to which people have been accustomed. But when there is no tin plate, then research in developing products is vastly accelerated by the urgent need and the availability of interest and funds for experiment and development. You may say we have always used tin plate and the trade will always go back to it. Perhaps it will, and perhaps it won't. As a small instance of the trend, tin plate has been used for screw caps for cosmetic jars. For the last few years, we have been making screw caps to look as much like plastic as possible, showing that the public would rather have plastic as regards eye appeal. If it will do the job, it will not be a long time before the public calls for an "enameled" coating. One objection is that you cannot solder enameled or lacquered black plate efficiently. There must be a means of closing the seam. If the tops can be closed by a non-metallic coating, then the seam can be closed by a non-metallic coating. If some of these other compounds or plastics can be formed thin enough and at the same time have enough strength, and can be made to resist the corrosive action of fruit acids, then the seams can be taken care of by a compound, resin or plastic. We are liable to end up by it developing that the final product used will not be "tin plate." Then, "electrolytic" is not the final answer but only an intermediate step. The hand mill made all black plate for generations, then on a cost basis the mechanized mill came in, but only as a "stop-gap." Then the strip mill took the sheet business and later took over the production of black plate for tinning. Do we know that electrolytic tin plate is not merely a stop-gap? — that the non-metallic coated black plate, or perhaps even a container that contains no steel, will take the place of most of the steel containers which we are accepting placidly simply because it has always been so made and so used?

There is a challenge to all of us to meet the present emergency. There is also a challenge to meet the long-time emergency and hold this package business for the steel industry. If it is not met, it will leave an awful hole in the steel business in "ordinary" times.

It brings this thought to mind: Everything you men have developed in the steel business you have developed on your own initiative, hoping the customer would like it — and the things he liked he bought. Why should the steel industry take this entire responsibility of finding out what is acceptable to the can companies, and then, as in the case of electrolytic tin plate, find it will cost as much as hot dipped plate except for the $10 or $12 saved in the metal — and then, if the product is acceptable, pass the saving on to the customer? Every time you make an improvement you do pass the saving on to the customer.

Here is a place for cooperation between steel engineers and the consuming industries to work out something

that will be acceptable, otherwise we may find we have made a lot of junk. With good cooperation from them, we may develop something good and acceptable, otherwise we may simply develop something that appeals to the eye and is all right except that the customer doesn't want it. Without a thorough knowledge of the customer's requirements and preferences, and without a complete understanding of his problems and needs — under present conditions and in the future — we may become engrossed in developing a better, even a perfect, "buggy whip," only to wake up and find that no one is buying "buggy whips."

JOHN M. READ: I believe the tin plate industry, such as we know it, is challenged on account of the substitutes for package containers which will necessarily be developed and exploited in this emergency. It behooves all of us, as representatives of the steel industry to apply our talents and recognize this challenge.

E. T. LORIG: There is one thing we must bear in mind. The steel industry is going into continuous strip production of coated products, which, to my mind, tends to circumvent some of the things brought out by one gentleman; and I think eventually that lower comparative costs will prevail which will tend to maintain steel plate for containers in the foreground.

L. F. COFFIN: There is one question I would like to ask Mr. Brown. Why is bonderizing used only for end stock and not body stock in cans?

C. E. BROWN: You have a metallic bond in ordinary tin plate which will solder satisfactorily with a tin coated interface face, and after it is soldered you have a covering bond established; but when bonderizing you have a non-metallic face with no metal bond. It might be possible to devise a material which can flow and act as a bonding agent, but so far as we know nothing has yet been developed. Latex was proposed, but with the general developments of using lighter gauge tin plate for your bodies, you have to depend a little more on strength of your seams as being helped by the solder bond. Somewhat heavier sheets were in use some years back. I think under those circumstances you would have been able to get away with latex, whereas today you do need the strength of your solder, or weld.

L. F. COFFIN: I understood you to say you had to use bonderizing for end stock only even where no soldering on bodies was required.

C. E. BROWN: It has been proposed for end stock on some sanitary cans, but to be coated with a synthetic coating. We do not know just how general the use is going to be, but there are some prospects that it can be used for body stock on items that would not require solder; but the greater quantity of your tin plate will be required for sanitary cans. You might say one-third for ends and two-thirds for bodies. At least you save the amount of tin that goes into end stock.

W. J. HENNESSY: Why do we not consider using the Bolivian commercial tin deposit during the present emergency?

C. E. BROWN: There is a smelter being built on the Texas coast which will supply at least a portion of the tin needs, but when we stop to consider the total amount of tonnage consumed per year for some years back, and knowing the hazards of transporting large amounts of the ore concentrates, and the problem of getting that tonnage through one smelter, we can hardly expect that we will get an amount of tonnage equal to our consumption. If the present situation continues you won't enjoy the tonnage of tin which is now available, in sufficient quantity to make it generally available and continue to be available for the wide variety of uses now. However, Bolivian tin has been used and in some cases it appeared rather promising.

E. W. HOPPER: My first job was with the American Smelting and Refining Company, on the electro-refining of tin, at their plant at Maurer, New Jersey. The tin concentrates from Bolivia were utilized and the plant was forced to shut down when these were no longer obtainable. All the tin ore from the Bolivian deposits requires hard rock mining as compared with the dredge and soft alluvial deposits of the Malay Straits. The tin smelted from this ore is high in impurities and it must be electrolytically refined to bring it to the same degree of purity as that recovered by simple fire smelting of the Malay ores. There is no reason why Bolivian ore cannot be taken out but there are no facilities for smelting and refining it in this country and there will not be for some time. A refinery is being built in Texas; it will take some time longer before it is in operation.

J. A. HELBLING: Have any attempts ever been made to weld the side seams on bonderizing material?

C. E. BROWN: I do not know how much work has been done on that particular phase. There has been work done on the welding of black plate. You do the welding after the can has been formed and the heat generated at the weld exposes the base metal so that you do not get any benefit from whichever synthetic coating was applied. There is no reason to expect you would get better results from electro welding a bonderized sheet; for even if the metal were fused I do not believe you would get any better results, although developments do look favorable for black plate.

BERNARD RAHILLY: I would like to ask Mr. Hopper whether the tin from Bolivia, notwithstanding its cost, can be utilized for the manufacture of tin plate?

E. W. HOPPER: There is no reason at all why it cannot be used. The impurities will probably be less than are in the present Straits tin.

I enjoyed Mr. Manion's comments very much, but I would not like to take too pessimistic a view right now. We can all recall the time when we could buy coffee only in paper bags. People decided there was better coffee to be procured when it was vacuum packed, and the only logical way to pack it was in a tin can. When having a dog became fashionable and it was a trial to buy and prepare dog food, it was put up in tin cans to make the job simpler. This use required millions of cans and the same thing will happen with other products.

Right now the glass manufacturers are evidently quite pleased over the present situation, but we have always had to compete with the mason jar. There will still be room for tin cans after this emergency is over if the producers of tin cans and the packers will play the game instead of expecting all the development work to be done by the tin plate producer.

P. N. BOSSART: Our experience indicates that electroplated tin is just as easy to solder as hot dipped tin if the coating thicknesses are about the same. Tin surfaces kept exposed to the air for a considerable time develop a film which in the case of a thin coating is

more troublesome in soldering than for a thick coating. In this case, satisfactory soldering can usually be done either by cleaning or by using a strong flux. Homer and Watkins, page 615 of *Metal Finishing*, November 1941, recommend minimum thicknesses of electro-tin coating for soldering of 0.0001 in. for storage up to six weeks, and thicker if storage is for long storage times.

C. E. BROWN: I think the problem of the particular products which will take the place of tin plate or black plate should be, in part at least, answered by the can companies, for the reason their own developments have been directed toward producing certain synthetic coatings. We know there are a great many cans for packing certain commodities, which it is obvious under present conditions are being made satisfactorily of black plate, under the condition of use; but when we speak of a sanitary can, we normally think of a vegetable or meat product that is packed in the can, sealed, and after that the can is heated in a retort and brought up to a relatively high temperature, 250F and held for 30 or 40 min. The probability is that black plate might be used, but at the present time the lacquer breaks down, due to poor adhesion. The problem with the general line cans is less difficult, in that generally it is not subjected to such processing conditions.

W. H. MANDY: Has there been any experimentation with the use of wax as a coating on black plate made into cans? My thought is that certain products might be packaged in wax-lined cans. The cans could be run through a bath of melted wax which would serve as a protective coating against rusting.

C. E. BROWN: When you think of operating at 250 to 350 fpm speeds, the conditions in the packing plant, handling costs and problems generally, it would probably establish the container at a figure so much higher that it would not sell as it sells now at 2 or 3 cents a can. There is only a remote possibility, that such a process would have any application.

CHAS. H. MANION: It seems to me it might be run through a lacquer.

C. E. BROWN: I think some work has been done along that line. They would much rather have it done in an easier way, although where they are forced to lacquer so much plate as today, they are not happy about that either.

FRANK E. JACQUES: Previous remarks and discussion of Mr. Brown's interesting paper, have been largely on either reducing the amount of tin required or other substitute coatings.

On the subject of rust prevention of black plate and its acceptance by the can companies, I think we would like to hear from Mr. Brown as to what might be termed an acceptable rust proof coating of black plate, one that would not only be acceptable to the steel companies but to the can maker as well. It has been my experience that frequently an inhibitor that meets the steel companies' approval, is rejected by the can company or vice versa.

C. E. BROWN: There are a great many films which have been investigated, and for one reason or another a great many of them do not appear to be satisfactory. They do not provide the rust protection when you coat them with lacquers, and in any event we are restricted to an oil which will subsequently stand dry packing. It is agreed you can lithograph or enamel without too much trouble. Most of the heavy base oils do not appear generally suitable, although there may be some exceptions, and of the other oils some will give fair rust protection, but the subsequent lacquer or enamel does not adhere well, and vice versa, some of them will provide good adhesion and yet do not give good rust protection.

There have been cases where some of the oils appeared as though they might have merit, but there was an odor which would not get past the customer's specification. For instance with cocoa, butter, spices and baking powder, it seems as if you don't have to have a heavy concentration to change the flavor of the product. That is another feature. However, I feel that there must be some oil somewhere that will solve a portion of the problem. I wonder at times, if we do not work with too little information, usually regarding the base of the rustproofing medium.

If we knew how the oil was compounded and the characteristics of the oil we might be able to evaluate the limitations of the material, as established by the family group. This would provide a considerable advantage in correlating results.

A. J. BERDIS: Installations for some processes are going ahead. Mr. Lorig mentioned he believed the cost would be down. From my experience, I think every device is being used to keep cost down and even the cost may be under tin plate. We are trying to put in lines that will operate at a minimum of cost and will probably be less than hot dip tin plate. This stop gap can and may pay for itself. Probably all these old hand mills paid for themselves, even though 50 per cent of them are abandoned and the companies have gone to strip mills. They paid for themselves in saving and in going ahead with the old processes; and even if some of this is a stop gap, it may pay for itself.

J. F. EDNIE: The subject of Bolivian tin ores is of vital importance these days because it is the only important source the United States apparently has at the moment. It has been long known that no appreciable amount of our present requirements could be supplied by domestic ores, even though there are reports that many of these domestic deposits are being worked extensively at the present time. While this is commendable, the total tonnage of tin from such sources must be regarded as insignificant.

Bolivian concentrates have been used in increasing amounts for the past several years, but it is noteworthy that under normal conditions these concentrates are not smelted alone — they are rather diluted with purer concentrates from other sources. The Tin Processing Corporation plant, being built in Texas City, is reputed to have capacity of smelting 50,000 tons of concentrates per year and producing 20,000 tons of pure tin. Nevertheless, from information available, it is not the intention of this company to smelt pure Bolivian ores. In other words, they also intend to sweeten the Bolivian concentrates with those shipped in from the East Indies. Since the latter concentrates are now unavailable, the problem of using pure Bolivian ores becomes acute.

There are several other plants in the country that have experience with these Bolivian concentrates, particularly the Phelps Dodge Corporation, National Lead Company, Vulcan Detinning, American Smelting and

Refining Company, American Metal Company, and others. The combined experience of all these companies indicate that it is impossible to produce tin in this country from Bolivian ores with tin prices that have prevailed for several past years. However, in view of present conditions, it would certainly seem that these companies should be requested to produce tin for the government at full capacity, independent of the production costs.

To anyone conversant with the tin situation, it is easy to understand why the Bolivian deposits have not been previously smelted in this country. Essentially, it was a matter of economics. The Far East ores were much purer and the base labor rate was extremely low. Nevertheless, looking at the picture in retrospect, it seems a pity that the government did not, long ago, squarely face that fact that a condition such as now exists could become a reality, and thereby make provision to smelt those deposits existing in our hemisphere. Under war condition, the cost of producing strategic metal becomes meaningless compared to its intrinsic value in turning out necessary armament.

In this connection, the situation with regard to rubber closely parallels that for tin. South America was once our principal source, but economic factors resulted in our importing most of the crude rubber from another hemisphere. With our imports now cut off, we find the South American supplies undeveloped and dormant. It is unfortunate that the government failed to foresee such a condition clearly or these South American plantations would be an immediate source. Not only would we be creating a good neighbor policy with regard to South America, but more important, we would be making the United States more independent and self contained, particularly with regard to these two vital materials in times of war.

L. I. FIELD: I would like to ask what determines the minimum thickness of tin that can be commercially used as a tin coating and whether the limiting factor is the soldering difficulty you run into or a possibility of porosity in the coating?

C. E. BROWN: On 1.50 lb coating, the film thickness is equal to 0.0009 in.; on the ½ lb coating it is about one-third of that. There must be some relation between the coating present and the soldering properties, but I feel that question could be better answered by some of our friends.

GEORGE H. RENDEL: Mr. Brown's paper is certainly on a timely subject. There are a couple of questions that arose in my mind. Mr. Brown noted particularly the changes in the product of hot rolling to cold rolling. I was just wondering if there would be a material change in the metallurgical specifications on the rolling of plates for substitute coatings? Also, he made mention regarding the substitution of lacquer and other protective materials, and I was just wondering what the outlook of possible shortages coming up in that line might be?

C. E. BROWN: After all, there are a lot of these questions that we can answer best by being second-guessers. I think we all realize the trends that we have experienced in all of our markets over a period of years, and while the Gallup poll shows one thing, sometimes the voters go in another direction; and I think the same thing is true with a great many of the substitutes that we anticipate. There are possibilities of new methods of applying the particular substitute, or changing the character of the film, or the film weight, or service conditions may change, because I think that generally the service conditions in the container field have changed a great deal over the last ten years. The customers are more critical; they are getting a better container; and the whole result is that everybody is happy except the sheet producer when he is criticized for something that the customer thinks he should get but doesn't always get. But it has always been a problem, and I think we are all aware of that. As for substitutes — in this particular case we are thinking of lacquers or enamels — there is some possibility of shortage. While I do not know very much about the formulation of lacquers or enamels, I do know that the people who supply them for the market are concerned as to the amount that is going to be available, and also as to the priority number that you will be able to give them in requiring a certain finish coating system.

Now, some of the people say that if you will use a certain type of size coating in conjunction with the finish coating system which they provide, you will get greatly improved results, and they have done some experimental work which supports that claim. Others just propose a size coating and say that if you use their size, why, it will do everything but grow hair on it. Still another group will say, "Well, we have something which will provide a nominal amount of protection, but we don't know what it will do. You will have to determine that by service conditions in the field." I believe that that is the situation, except that there is going to be a shortage in some of these materials that go to make up the synthetic coatings, and just how much or how generally they will be restricted I don't think any of us know at the present time.

In the matter of processing — that, I judge, has to do with the metallurgical condition of the finished sheet as well as the service condition — I think that there is a requirement there that will have to be met. I do not anticipate for the moment too much in the metallurgical condition, because your tempers for can manufacturing and drawing purposes are pretty well established; and unless there is some new technique that is developed for obtaining a certain type of temper or a certain alloying element that might be applied, I don't see much change in the general condition of heat treatment. In the matter of surface, I think there is something, because I believe that all of us who have had anything to do with the hot roll sheet product realize that when we made certain black finishes for the lithographer, in some cases a fellow would want a three-pass sheet, in another instance a fellow will want a two-pass sheet, and in still other cases a man will desire a one-pass sheet, just to give what the lithographer calls "tooth" for enamel adhesion. And I think it is desirable to get that same preferred condition of surface which, in our present experience, looks as though it will be applied in the temper mills. I believe there is a certain advantage there. I don't believe with any of these applications that we have a sufficient background of experience to say positively that we will do a certain thing and won't do something else, because as our requirements change, our opinions will also change and they will thus change the process accordingly.

(*Please turn to page 74*)

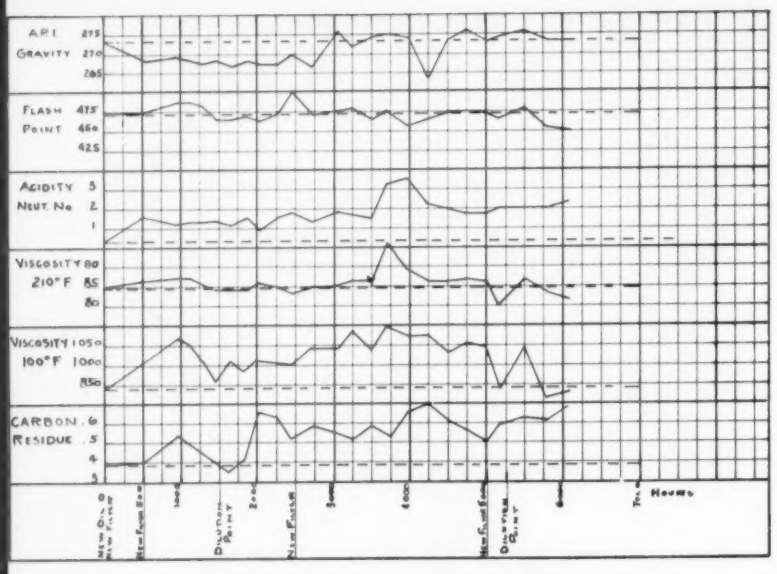


Figure 1 — Crankcase oil tests of locomotive No. 44 from March, 1938, to March, 1939.

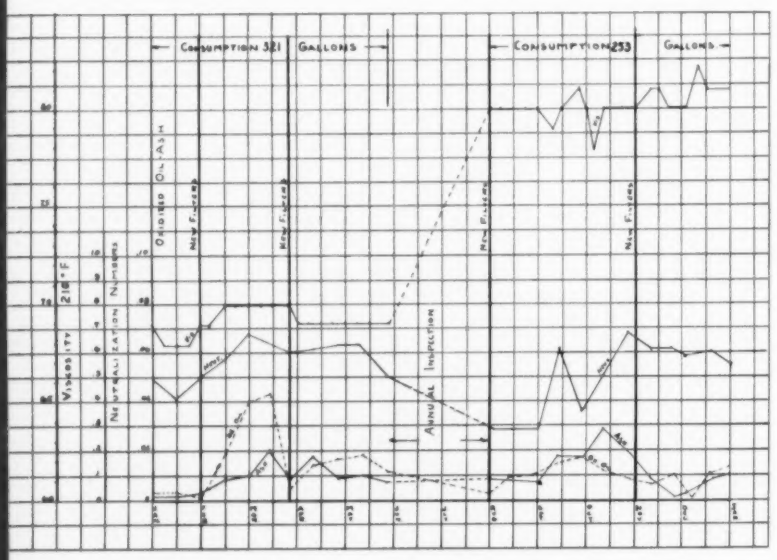
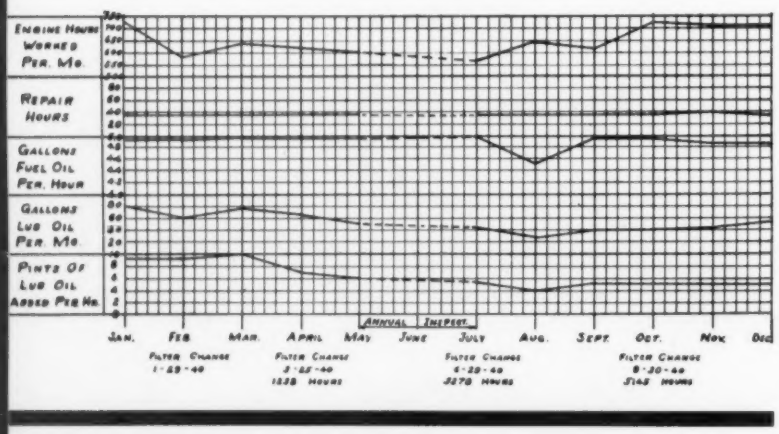


Figure 2 — Crankcase oil record of locomotive No. 45 for 1940.

Figure 3 — Record for 1940 on locomotive No. 45, 100-ton class, two-cycle, straight eight diesel electric.


Engine Hours Worked Per. Mo.
Repair Hours
Gallons Fuel Oil Per. Hour
Gallons Lub Oil Per. Mo.
Pints Of Lub Oil Added Per Hr.
Annual Inspect.
Jan. Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.

▲ NO attempt is made in this paper to suggest the proper lubrication of diesel engines, but rather to touch on interesting portions of the Inland Steel Company's experience and practice with two and four cycle engines in diesel-electric and direct drive locomotives of the 60 and 100 ton class.

The practice of extending oil changes from annual inspection to annual inspection is discussed along with the use of large size adsorbent type filters. Curves showing test runs are presented to illustrate the results of the yearly oil change.

General lubrication practice, filters, liners, rings and bearings complete the scope of this paper.

DIESEL

Service Life of Oil

Crankcase lubrication of the high speed, two cycle diesel engine is recognized as one of the toughest of lubrication problems. Considerable progress has been achieved in the last ten years along the lines of decreased sludge, less ring sticking, better cylinder liner life, etc. The recent wide spread practice of using oils containing "additives" and the correct blending of stocks from the various crudes have done much to accomplish these results. However, I think all will agree with me that the perfect oil is still a matter of the future.

The greater part of the following remarks of this paper pertain to the two cycle diesel engine. Service life of the diesel crankcase oil depends a great deal on the type of use to which the engine is subjected. In ordinary switching service we believe the oil may be used for a year without the necessity of a complete drain. To substantiate this a locomotive with a large size adsorbent type filter was selected and run under the usual service conditions with the same oil for somewhat over six thousand operating hours. Samples of the oil were then taken approximately every one hundred and fifty hours and analized for A.P.I. gravity, flash point, fire point, carbon residue, viscosity at 100 F, viscosity at 210 F, per cent dilution and per cent acidity.

The results were plotted (Figure 1) and carefully checked. The curves show the following results:

The A.P.I. gravity curve was generally lower than the starting point, varying at the most one degree from the original oil (27.3 to 26.3) and an average of about one-half of one degree.

The average of the flash point remained constant at 470 F. Sometimes higher and sometimes lower, but never any great variation.

Acidity or neutralization number, a factor we were deeply interested in, was always higher than the new oil with a maximum rise of .31 and an average rise of .11. This curve was a bit disappointing inasmuch as there

were no sharp drops when the filter cartridges were changed. At no time did the acidity become high enough to warrant alarm.

The viscosity at 100 F and 210 F did not correspond with each other. The 100 F viscosity curve was always higher than the new oil while at 210 F the average was only slightly higher than the new oil and at several points was below the original viscosity. The apparent discrepancy between the two curves was probably due to the loss of volatile material between the two test points of 100 F and 210 F, or it may have been caused by nuclei of carbon, dust, etc.

Carbon residue was generally higher with the used oil, the maximum rise being .31 per cent and the average rise about .10 per cent.

Per cent fuel oil dilution averaged six-tenths to eight-tenths of one per cent with two short periods about one per cent. These high points of dilution occured at 1500 hr and 5250 hr of operation and did not affect any of the curves except viscosity.

These results were considered quite favorable, but it must be kept in mind that make-up oil on this particular engine runs about sixty per cent a month and filter cartridges were changed four times during the year.

Oil Control System

To insure the safe use of lubricating oil over a years operating time a system of analysis has been established. Samples are taken from each engine at seven day intervals while the locomotive is in operation. Our laboratory reports the viscosity at a hundred and at two hundred and ten degrees every week and neutralization number, water and ash every alternate week. The laboratory results are phoned direct to the round house where they are checked against a condemning-limit chart. If any of the limits are exceeded the lubrication engineer is consulted and a decision is made as to the continued use or change. Later a written report is sent through by the laboratory and the results are recorded in chart form such as Figure 2.

This chart shows the years record of the oil and is very valuable for reference. A record of oxidized oil was kept in the past, but has been discontinued inasmuch as it never became erratic. Viscosity is the factor watched closest of all and tells us if there is any serious dilution. Large quantities of water or serious fuel oil contamination are the only items that have caused us to change oil before the year is up. Figure 2 shows that a heavier lubricating oil was used after the annual inspection, the reason being that most of the old pistons and liners were put back into the engine. The heavier oil resulted in a lower neutralization number and reduced consumption. The first five months the average monthly consumption was 64.2 gal, the last five months shows the consumption was 50.6 gal per month.

Filter changes are determined by the color and general condition of the oil and generally range about every ninety days. The neutralization number condemning-limit is 1.0 and with the adsorbtion type filter we have never approached this limit. Our curve shows no decided change in the oil when new filters are installed although color is improved.

Along with the lubricating oil curves, a chart is kept (Figure 3) showing consumption of fuel, lubricating oil, working hours and repair hours.

Filters

The oil filters used on these engines are a mineral of adsorbent type filter consisting of six cartridges of baked fullers earth wrapped with an inner and outer layer of sulphite pulp paper. The unit is connected between the supply tank and the engine and adds about thirty gal to the oil capacity of the engine. Pressure is maintain around fifteen psi.

It is general opinion that this type filter will remove most of the present type additives, but we have reason to believe from our tests on this subject that the filter will retain a major portion of the additives and then under continued use will release the additives back to the oil. This is an interesting phenomenon that warrants further investigation.

Economically the use of the filter against an oil change every ninety days, comes out about even. However, we believe the use of the adsorbent type filter keeps the oil in better condition than other type filters we have used. Also, the large crankcase capacity is desirable.

Piston Rings and Liners

It is debatable whether piston rings operate under conditions of boundary lubrication or under fluid lubrication conditions. It is quite probable that both conditions exist, tending toward boundary lubrication for positions near dead centers, where the piston speed is slow. Also it is recognized that the oil films will tend to leave hot areas and move to cooler areas, thus diminishing the film near the top of the piston stroke, the area where most wear occurs.

The results of these two factors are prevalent in the two cycle engine which, generally speaking, shows more

ENGINE LUBRICATION

By D. N. Evans

Lubrication Engineer, INLAND STEEL COMPANY, Indiana Harbor, Indiana

Presented before the
A. I. S. E. ANNUAL CONVENTION, Cleveland, Ohio

wear than a comparable four cycle engine because of the hotter pistons and scraping action of the ports against the piston skirts. The recent application of oil spray pipes from separate pressure systems and directed against the inside of the piston to remove the excess heat has accomplished a great deal toward reducing wear of pistons and liners and reducing ring sticking.

Ring sticking may be caused by one or more of the following factors:

1. Carbonaceous deposits, resulting from deterioration of the lubricating oil in the ring grooves, on the lands, and on the piston crown.
2. Soot deposits from combustion.
3. Other products of contamination, such as wear products from the engine, ash from the fuel and dirt from the atmosphere.

In my opinion, the second item, soot deposits from combustion, is a very large contributor to ring sticking. We find that deposits scraped from stuck rings are in the range of eighty per cent soot, one to seven per cent lacquer, one to five per cent asphaltenes, and oil up to twenty-five per cent. This would mean that the more cylinder wear there is the easier it will be for the combustion soot to collect on the top rings. Consequently, good mechanical condition of the liners is extremely important to minimize ring sticking. Using a piston liner beyond its condemning limit, which in the case of an eight in. bore is twenty thousandths of an in., is to invite ring sticking problems.

Engine conditions will cause the intensities of the various processes (oxidization, polymerization, carbonization, etc.) to which the lubricating oil in the ring grooves is subjected to vary. Consequently, engines of the same make and using the same oil will give different results because of the different operating conditions. Engines under full load cannot be compared with similar engines under fluctuating loads.

"Additives" to lubricating oil are apparently making headway toward reducing the ring sticking problem. Effective additives may or may not reduce the amount of carbon in the ring grooves. In event the carbon is not reduced the action is such as to delay the ring sticking properties of the carbon already formed, such as softening the carbon bond, etc. Weighing the carbon found in piston rings cannot be used as a comparison for test oils for the above reason.

Bearings

Our engines are now equipped with a lime hardened lead bearing on the top half of the crankshaft and the bottom half of the connecting rod. A bearing with a "copperlead dispersion" lining is used on the top half of the connecting rod and bottom half of the crankshaft. Inasmuch as the major loads are on the top half of the connecting rod and bottom half of the crankshaft it would be reasonable to assume the results on the "copper-lead" bearing as the determining factor. There has been no indication of corrosion in either type bearing.

A scratching condition occurs on most of the bearings for about 20 per cent of the surface. This is undoubtedly due to particles of carbon, dust, metal, etc., in the lubricating oil and of course is more prevalent in the lead half than in the copper half. However, this is not serious enough to impair the efficiency of the bearing.

Several cases of incipient fatigue failures have been discovered in which small patches of babbitt have left the shell and generally there is a black discoloration on the back of the shell indicating poor heat transfer from the bearing shell indicating poor heat transfer from the bearing shell to the connecting rod. No failure from poor bonding or imbedded particles have been uncovered to date.

More crankshaft wear occurs with the "copper-lead" bearings than with the babbitt type, but the bearing life is considerably longer.

Fuel

One fuel oil satisfies the four types of diesel engines used in our switching service. The main specifications are as follows:

Viscosity at 100 F	41
Cetane number	54
Flash, F	230
A.P.I. gravity	35.2 to 40
End point, F	735
Sulphur, per cent	.36

Dirt and water are by far the most serious offenders experienced with fuel oil. It is absolutely necessary to keep the fuel clean if good operation is desired. Contrary to general practice the suction line on our main fuel oil storage tank reached below the bottom of the tank into a small recess. All water, if any, is immediately discharged into the engine with this arrangement and the main tank is kept free of water. This would seem to be asking for water trouble, but the amount of water each engine gets is evidently so small that it does not affect the operation of the engine.

Stuck injectors from fuel oil gave some trouble for a while with one type engine. The sticking usually occured when the engine was shut down and the engine heat was sufficient to cause lacquer formation between the plunger and injector bushing. This trouble disappeared during winter operation and can be controlled at all times by bringing the engine temperature down as low as possible before shutting the engine off.

Miscellaneous Diesel Lubrication

All electrical equipment on the locomotives is lubricated with a high quality lime base grease with a three hundred second oil and worked penetration of 280. Other parts and bearings requiring grease are lubricated with a soda base grease with a four hundred second oil and a worked penetration of 350. These two greases take care of everything with the exception of motor pinions and drive gears. On these we use a heavy asbestos filled compound that has given excellent results. Gears and pinions are in excellent shape after six years of operation and there has been no leakage over to the suspension bearings. Pinions have been lost

by cracking through the bore, but not because of tooth wear.

Drained motor oil is run through a re-claiming machine and used for journal bearings and general oiling thus making good use of all the old oil. Air compressors and governors use the same oil as is used in the engine crankcase. A light oil is used for the air filters, bell-ringers, etc.

General lubrication other than the crankcase has boiled down to a matter of routine, but considerable care and vigilance is given to the engine itself to assure proper and profitable lubrication.

DISCUSSION

PRESENTED BY

T. R. MOXLEY, General Master Mechanic, Wheeling Steel Corporation, Steubenville, Ohio

D. N. EVANS, Lubrication Engineer, Inland Steel Company, East Chicago, Indiana

T. R. MOXLEY: I would like to ask Mr. Evans if in the application of the filters to the diesel engines they have ever had an occasion to change the design of the filter that was originally employed on this diesel engine from the time it was built up to now.

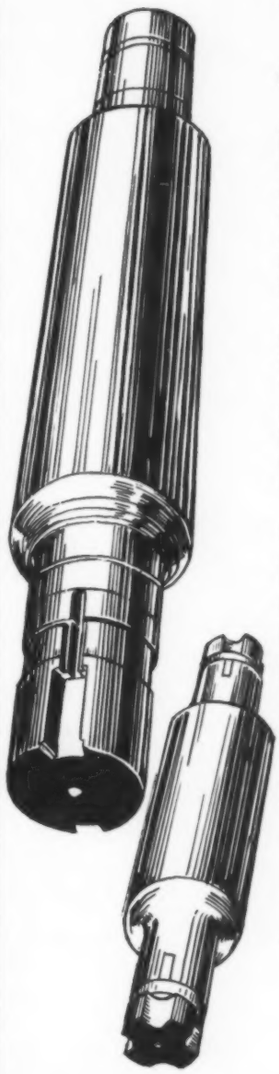
D. N. EVANS: Yes, we have changed that design several times, mainly to provide for a good installation in the engine. We find that most locomotives are built with very little extra space for new equipment. We have changed the arrangement of cartridges and the size of piping to it and the location several times, but the principal operation of the filters always remains the same.

T. R. MOXLEY: Another thing I would like to ask Mr. Evans — you say that, "the acidity or neutralization number, a factor we were deeply interested in, was always higher than the new oil with maximum rise of .31 and an average rise of .11." Could you explain as to why that condition existed and why it doesn't cause you any concern?

D. N. EVANS: It causes concern inasmuch as it is closely watched, but this type cartridge in the filter, is designed to control the acidity, and it seems to be doing a job. As long as the acidity remains below a reasonable figure, we are not concerned, but when sludging conditions are approached acidity is an important item.

T. R. MOXLEY: That is part of the answer I wanted you to give in the first place, because I thought surely if you were perfectly satisfied in the acidity of the oil after it had run a considerable time that you must have made or must have been perfectly satisfied with the filter installation as it originally was or you must have made some changes in order to obtain the results you seem to be satisfied with.

NATIONAL ROLLS



The Reassurance of Dependability

ROLLS, of all units in steel and iron production, must serve steadily against the crushing resistance no other industrial part is called upon to endure.

Failure, inevitable to improper base processing, faulty chilling, or careless machining or grinding, can stop production and cause loss many times greater than the cost of the roll.

In NATIONAL ROLLS, the responsibility is accepted, as we believe them to be as strong, as uniformly hard, and as perfect in machining and surfacing as any in the world.

We regard our technique as an art of which to be proud, with profit only a reward for discharging responsibility.

W. H. Seaman

President and General Manager

THE NATIONAL ROLL & FOUNDRY CO.

Rolls & Rolling Mill Equipment

AVONMORE, PA.

▲ LIGHT alone affords little, if any, protection to property. When combined with an adequate guard service and when designed to help the guard detect the presence of an intruder light becomes a necessity. In short, light is practically worthless without an adequate guard and a guard is inadequate without the help of a proper lighting system.

Before attempting to design a protective lighting system it will be worth while to put yourself in the place of the saboteur and then in the place of the guard and make some practical observations keeping in mind always that the saboteur is smarter in his business than you are and that the guard is dumber than you are. Let us suppose we have a manufacturing area inside an 8 ft fence with three strands of barbed wire slanting inward. The fence is lighted to a distance of approximately 200 ft outside the fence. A guard is employed to patrol the fence line keeping himself inside of the dark area for his own protection and to keep the saboteur in ignorance of his whereabouts. The saboteur wants to get inside the fence. One simple ruse on the part of the saboteur would be for his accomplice to make a commotion at the fence some distance away and engage the guard's attention while the real saboteur gets over the fence. (There are several other ways to accomplish the same result.) If the barbed wire slanted outward the fence would be harder to climb. It is often easier to dig under the fence instead of going over it.

lem for us. There is no purpose in trying to keep the road darker than full moonlight on a clear night (0.025 ft-c) as this condition often exists. Full moonlight also is approximately the illumination for safe driving. (When the driver's eyes are dark adapted, driving is possible under much less than 0.025 ft-c but on the other hand with a lighted fence the driver's eyes are not completely dark adapted.) There is no practical advantage in having the patrol road in darkness as under usual night sky conditions the patrol car can be seen and if not seen, heard.

Our original problem has now advanced to a good guard practice. We now have a manufacturing area with an 8 ft fence with three top strands of barbed wire extending outward. Fixed guards in towers spaced on approximately 2000 ft centers and with the guard approximately 35 ft above the ground and having at his disposal an adjustable narrow beam searchlight and two way radio communication with a mobile guard operating on a patrol road approximately 50 ft inside the fence. (115 volt service is required in the fixed guard tower for a 1500 watt search light and a 1000 watt heater for winter use.) The patrol road must be illuminated to a degree approximating full moonlight on a clear night (0.025 ft-c). The remaining problem is how to most effectively light the area inside and out of the fence and at the same time do its most economically both as regards first cost and operating cost.

PROTECTIVE LIGHTING

for Industrial Plants

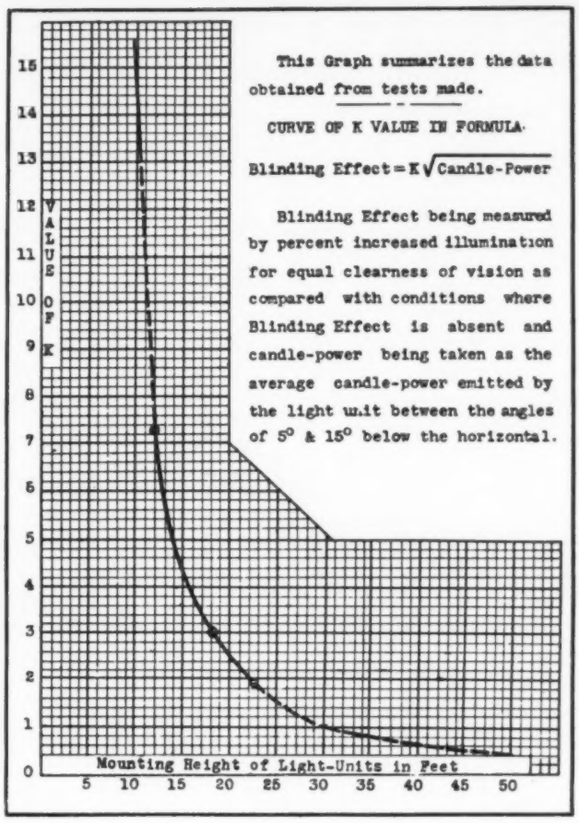
By D. H. Tuck

Electrical Engineer, HOLOPHANE COMPANY, INC., New York, New York

This example shows the necessity of having a fixed guard and good practice is to erect guard houses on approximately 2000 ft centers with the guard approximately 35 ft above the ground. With adequate light along the fence the guard can see at least to the next guard tower. The guard in the tower must be equipped with a telephone to the captain of the guard or two way radio telephone. Inasmuch as the effective use of fixed guards depends on his not leaving his post under any circumstances an additional mobile guard who can respond to a call quickly is necessary. This requirement has resulted in good practice of a patrol road approximately 50 ft inside the fence. The patrol guard is similar to the well-known police radio squad car. He has two way radio communication with the tower guard. The tower guard advantageously has an adjustable narrow beam search light at his disposal. It is considered a help to have the patrol road in comparative darkness so that the saboteurs cannot readily locate the position of the mobile patrol. On the other hand there must be sufficient light on the patrol road for safe driving without headlights. Fortunately nature answers this prob-

Refractor units have a tremendous practical advantage in that they have a 30 year record of trouble-free service in street lighting application all over the world where over a million are in use. They are a standard item of many manufacturers and so are readily available on a competitive basis. Another practical advantage for refractors is that they are available in various sizes for multiple lamps from 75 to 500 watt sizes and for series lamps from 1000 to 10,000 lumen sizes. They are also available to produce symmetrical distributions of light as well as a large variety of symmetrical light distributions so that whatever the concept of proper light distribution may be, there is a refractor type to meet the requirement. The vertical angle of maximum candle power is easily adjustable by changing the lamp position in the refractor to meet any practical ratio of spacing to mounting height.

Some practical consideration of the methods of plant protection by the combination of fixed and mobile guard and light will be of interest because they influence good practice. Glare is a function of mounting height as shown in Figure 1. It will be seen that 25 ft mounting


This Graph summarizes the data obtained from tests made.
CURVE OF K VALUE IN FORMULA
Blinding Effect = K√Candle-Power
Blinding Effect being measured by percent increased illumination for equal clearness of vision as compared with conditions where Blinding Effect is absent and candle-power being taken as the average candle-power emitted by the light unit between the angles of 5° & 15° below the horizontal.
VALUE OF K
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Mounting Height of Light-Units in Feet
5 10 15 20 25 30 35 40 45 50

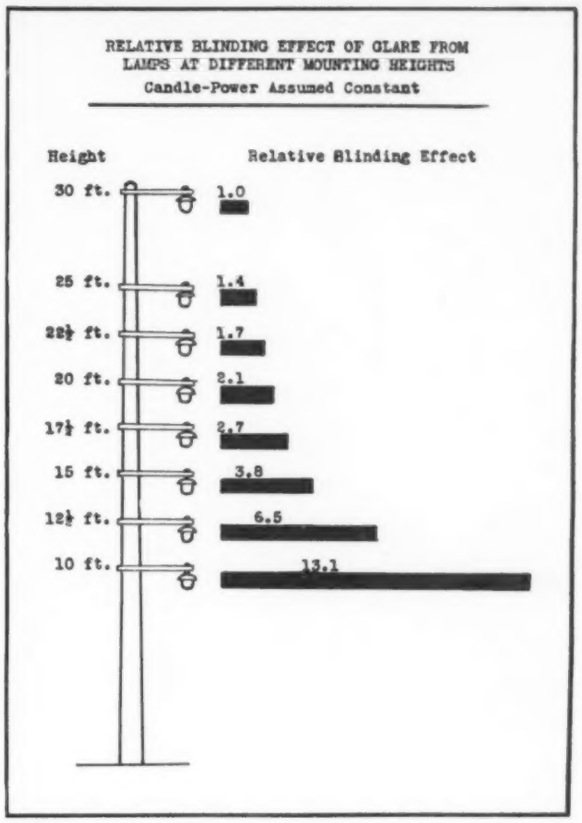


Figure 1 — Charts showing relation of glare to mounting height of lighting unit.

height is a practical one from the standpoint of glare reduction and readily available poles. Elimination of glare is necessary for many reasons:

1. Patrol car driver must not be subjected to glare because it would reduce his vision.
2. Glare is not permissible along highways, railroads or navigable waters.
3. At first thought glare in the direction of the saboteur (outside the fence) would be an advantage in that he could not see the mobile guard. The saboteur can by the simple expedient of looking through a black tube or pipe completely eliminate the glare and see the guard as well as if there were no glare. It is also well to remember that the saboteur can make the guard come outside where the guard would be at a disadvantage. It is best therefore not to tolerate glare from any direction.
4. A 25 ft mounting height has another practical advantage over lower mounting height in eliminating elongated shadows made by irregularities in terrain or obstruction as such shadows would afford a hiding place for a saboteur.

The fence offers an obstruction to good vision from the standpoint of the mobile guard (the tower guard sees over the fence and being 5 ft above the lights his vision is maximum). If the lights are placed too far back from the fence the inside vertical surface of the fence is illuminated and causes a veiling or back glare which makes it difficult to see through the fence. If the lights are closer to the fence then transmission of light through the wire mesh at small angles causes a reduction in illumination just outside the fence. The optimum location of the light is therefore practically over the fence.

In most instances the property outside the fence is grown over with weeds or woods and there is no advantage in trying to illuminate beyond the fence greater than the cleared ground. The illuminated area outside the fence should be kept mowed. Light that would be wasted in unkept area outside the fence should be utilized in the kept area by employing the proper asymmetrical distribution of light.

It is important that the area between the fence and the patrol road be illuminated so that an intruder who has made the fence can be apprehended. In fact it is even more important to be able to see a saboteur inside the fence than outside because he is potentially more dangerous when outside.

Spacing of lights should be selected so that a failure of one lamp would not seriously impair the effective uses of the protection afforded by having unlighted pockets midway between units. The amount of light required should be selected for the poorest condition of contrast, i.e., dark terrain and the saboteur with dark clothing. Integrating all of these considerations good practice is:

Units — General Electric Company, catalog No. 79VR or 79R for series or multiple lamps; Holophane

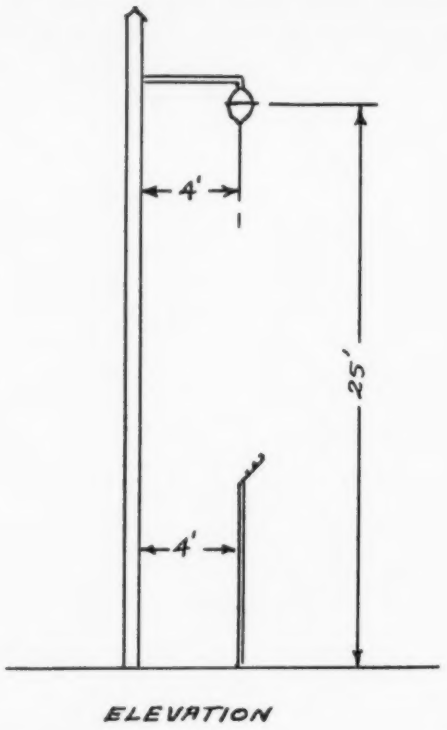


Figure 2 — Sketch showing a good arrangement in protective fence lighting.

Figure 3 — Typical good practice in protective lighting of boundry fence.

Company, catalog No. 04376-A for multiple lamps only; Line Material Company, catalog No. 602004-C 5G for series lamps, No. 602004-C 80G for multiple lamps; Philadelphia Electric Manufacturing Company, catalog No. 608 AR for series lamps, No. 609A for multiple lamps; Westinghouse Electric and Manufacturing Company, catalog No. S-1121601 for series lamps, No. S-1122403 for multiple lamps.

Lamp size — 300 watt multiple or 6000 lumen series for fence lighting.

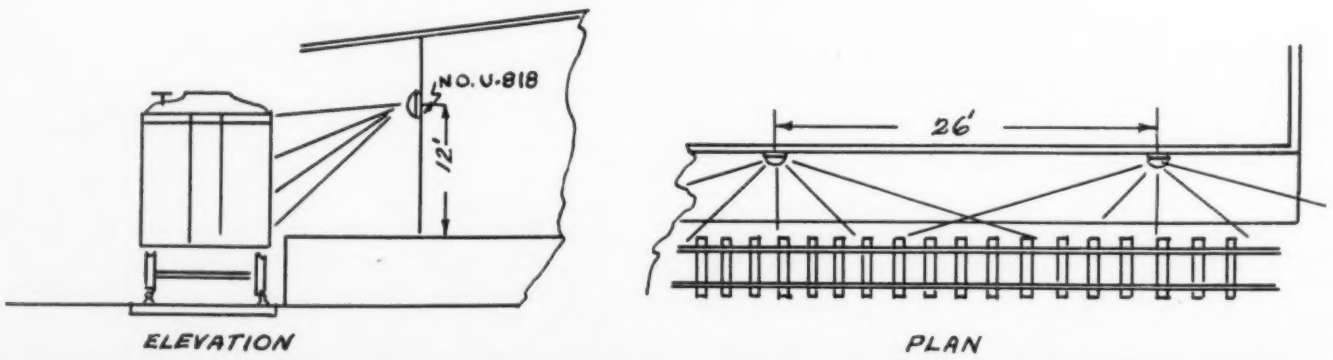
Spacing — Poles spaced on 150 ft centers.

Mounting height — Locate bracket so that bottom of unit is 25 ft above grade.

Pole location — Locate pole so that bracket will bring unit approximately over fence. (Note: This specification is in accord with "Standard Specifications for Fence Lighting," No. 6403-E, Oct. 15, 1941, of War Department Office of the Chief of Engineers Construction Division — Engineering Branch.)

Circuits — The multiple circuit has some practical advantages. Ordinary 115 volt lamps can be used. Disconnecting hangers can be used without the expense of individual insulating transformers. Ordinary circuits are employed. Safety of relamping due to elimination of high voltage at lamp socket, 115 volt circuit of 2500 watt capacity is required at guard tower. Single phase 2300 volt, 60 cycle primary and 7.5 kva, 115-230 volt secondary transformers are used. Each transformer will take care of eight 300 watt lights on each side or 16 in all, and in addition, the 1500 watt guard tower searchlight and 1000 watt guard tower heater. The conventional two wire or REA type circuit is used. The

Figure 4 — Shipping platform lighting designed to be out of the way and to light interior of car as well as platform.

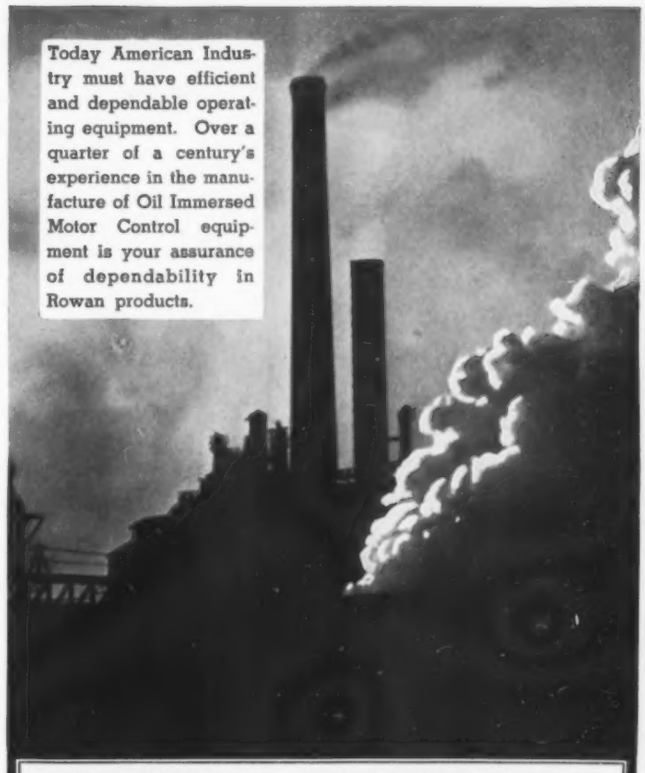


series constant current circuit has been used in the majority of the existing installations. Individual insulating transformers are used where disconnecting hangers are used for servicing the lighting units and for the 115 volt guard tower circuits. Either the multiple or series circuit represents good practice.

Roadways — Roadways leading to and inside the plant offer the same problems as ordinary highway lighting where refractors are used as standard equipment. More illumination is required for roadways than for fence lighting. Lamps of 500 watt, multiple, or 10,000 lumen series are used. The spacing is 150 ft and the mounting height is 25 ft. The same units are used as for fence lighting except that larger lamps may be used in some cases. The pole location is on the far side of the drainage ditch and a bracket is used to bring the light over the edge of the road.

Paths, over doorways and around buildings — Units with 200 watt multiple lamps mounted approximately 16 ft above grade, and spaced on approximately 100 ft centers may be used for walk way lighting. The same unit is used on a ½ in. goose neck for over doorways and around important buildings where night traffic warrants such lighting.

Shipping platforms — Shipping platforms located on both truck and railroad side of a warehouse are lighted with units mounted on the back wall of the warehouse. Mount approximately 12 ft above platform and space on approximately 26 ft centers. The light distribution is such that the inside of trucks and box cars will be illuminated with 200 watt multiple lamps in the units.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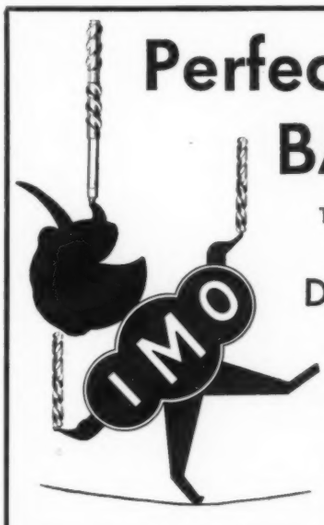

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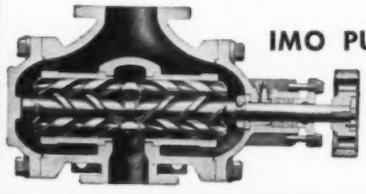

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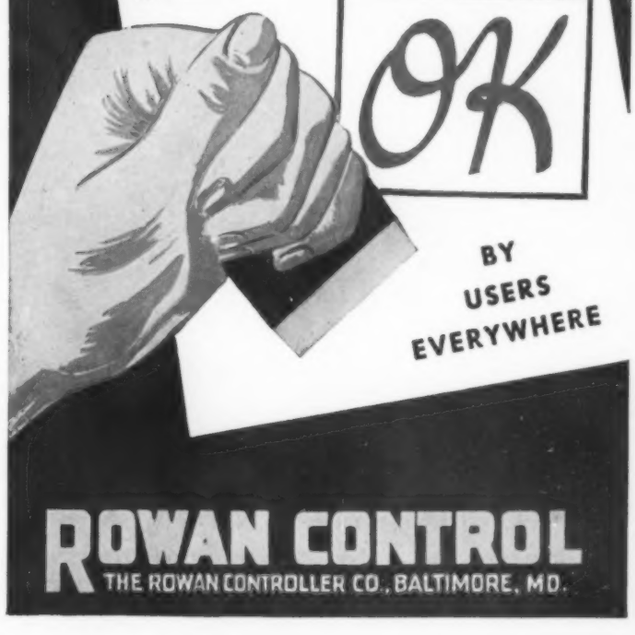

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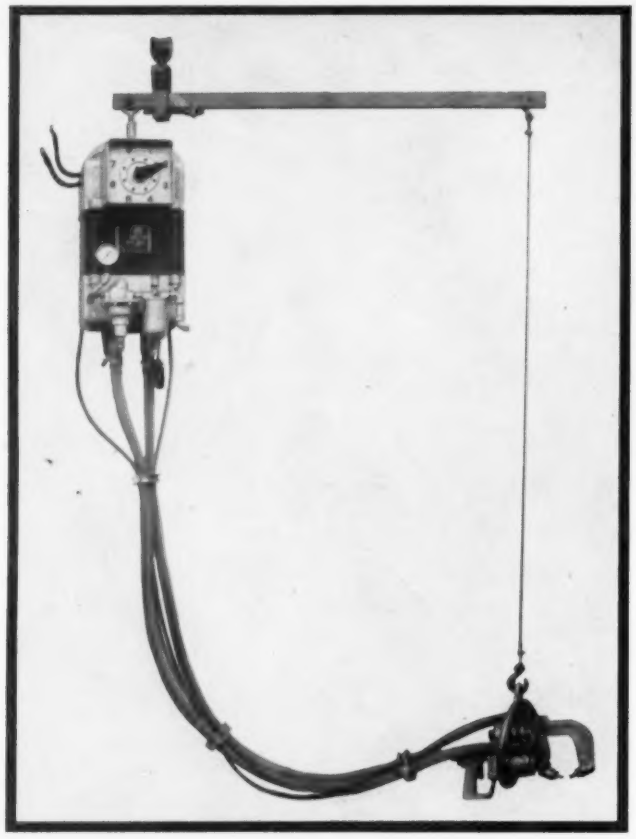


Figure 1 — Portable type of spot welder. ↑

▲

Figure 2 — Semi-automatic spot welder for joining coils in low production. →

Welding in COLD STRIP PROCESSING

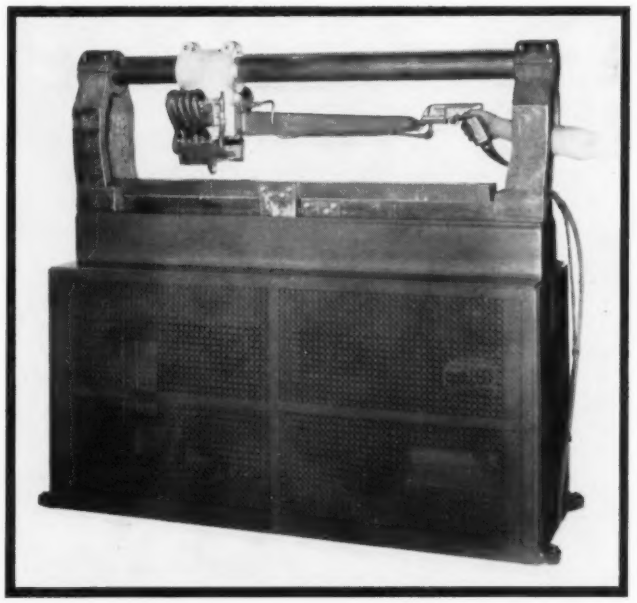
By J. H. Cooper

Welding Engineer

THE TAYLOR-WINFIELD CORPORATION

Warren, Ohio

Presented before the A. I. S. E. ANNUAL CONVENTION
Cleveland, Ohio



▲ THE resistance welding of strip in processing in steel mills concerns the unusual situation of dealing with a demand for the highest weld quality which can be obtained by any welding process, and at the same time concerns the production of welds of the poorest quality made by any industry.

This situation is created by the need for welds made in strip to withstand the stress of a high percentage of cold reduction on one hand, and by the need for welds which only have to hang together long enough to get through the particular processing step involved, after which they are cut out as scrap, on the other hand.

The resistance butt flash welding process meets the requirement for the highest weld quality which can be obtained by any process.

Resistance spot lap welding whether done by welding points or circular electrodes meets the requirement for the rapid production of joints in strip with a minimum of initial investment and maintenance.

However, since the strength requirements of a weld to pull the strip through most steps of processing are so low, a weld made in most any manner is usually adequate. This results in a quality of tip or wheel electrode maintenance, which would not be tolerated in any other industry. The resulting welds in many cases are badly burned and hardly can be called welds, nevertheless, they serve their purpose. The fact that the final resulting weld need not be of very good quality cannot be permitted to carry its influence over into the design of welding equipment. Such welding equipment must be designed with more attention to ruggedness, simplicity, low maintenance and ease of operation, than welding equipment for any other industry. Early forms of resistance welding equipment for steel mills lacked the item of sufficient ruggedness as welding equipment manufacturers learned to their cost.

Equipment for spot welding takes many forms de-

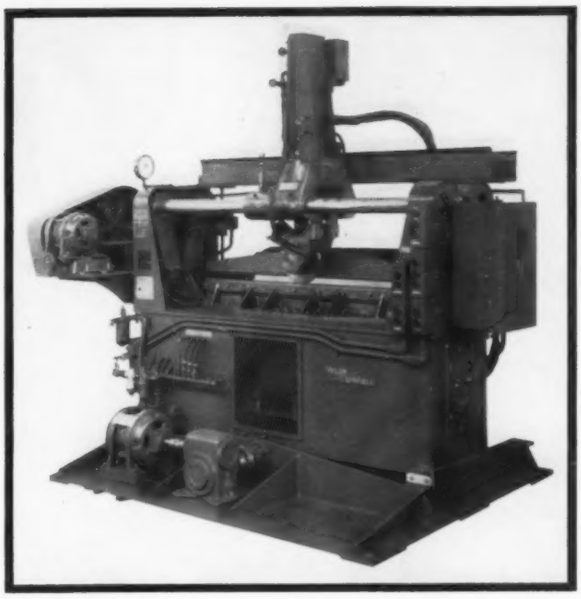


Figure 3 — One type of automatic roll seam welder used to make spot welds for joining coil ends.

pending on the range of gauges and strip widths and on the production involved.

Figure 1 shows a portable gun welder used where the strip is relatively thin and narrow, but where the welder must be moved to the work as in a multiple strand pickle line.

In general these welders have not found wide favor as the gauge and strip width which can be welded is limited. Also these guns are of a design originally developed for automotive work, and are usually too light to take the heavy service required by steel mills. If designed and built heavy enough for mill service, they then impose too great a load on the operator, and other automatic, or semi-automatic, types of equipment constitute a better device. In spite of these disadvantages, there are a few applications where this type of apparatus fills a necessary place.

Where the strip to be welded is relatively thin and of medium width, such as tin plate stock, and the time involved for the welding operation may be 3 or 4 min, apparatus such as Figure 2 can be profitably used.

This type of electrical circuit is quite common for both spot and roll welders for continuous strip. It consists of a base containing a transformer which has one side of its secondary connected to a copper platen bar over which the strip passes and which is protected from excessive wear due to the strip by rolls on either side of the welding platen. The other terminal of the transformer is connected to two copper castings, which are joined by a copper bar upon which rides the welding head. When the welding pressure cylinder is energized, the electrode shorts between the current conducting upper bar and the platen beneath the strip, carrying the welding current and making the weld. The two copper castings form members of a low impedance circuit whose chief characteristic is a minimum of change in welding current per spot as the shorting bar proceeds in either direction from the position in the center line of the welder. The operation is such that as each spot weld is made, the operator must move the welding head to each succeeding location and energize the firing trigger for every weld. Using such equipment restricts the operator to only one row of welds across the width of the strip unless the strip itself is moved the necessary few inches to make more rows of welds. The time required to make welds with such equipment is relatively long as witness the above 3 to 4 min.

For apparatus to do the same type of welding as that done by equipment shown in Figure 2, yet to do it in a shorter time, the type of apparatus shown in Figure 3 was developed. Here, a motor driven welding head carrying a welding roll is used instead of a welding point moved by hand. The electrical welding circuit is essentially the same. Air operated clamps are provided to hold the strip in the welding position on the platen bar. The whole welder is quickly moved laterally by a traversing mechanism to make more than one row of welds without having to move the strip itself.

The welding current is delivered in a series of impulses by a simple timer and the result is usually a series of welds approximately 1 in. long, spaced on approximately 3 in. centers.

The use of such a timer has two clear advantages, the first being that burning of the strip and making defective welds is reduced and the second is that the interrupted welds minimize warpage of the strip.

The operation of the equipment is automatic in that the operation of the control button causes the electrode to contact the strip, start its travel, make the weld,

Figure 4 — High production travel head series roll seam welder which simultaneously makes two rows of spot welds.

stop at the end of the weld and release welding pressure.

Such welders will weld up to .125 in. strip or heavier. However, for gauges heavier than .078 in. it is recommended that the drive be of the ratchet type giving a longer "dwell" time during the period of welding current flow.

In addition to the ratchet drive, for material .125 in. and heavier, the lower platen bar or spline must be replaced with a moving roll matching the one above to localize the current in a smaller area than is possible with a platen bar.

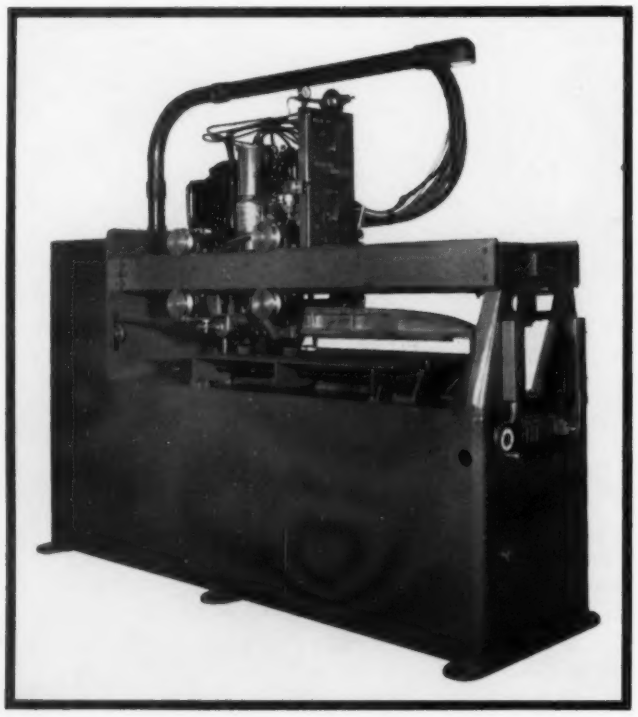
All of the above applies to clean steel only. If coated strip such as galvanized, terne plate, "Zinc-Grip," "Paint-Grip," "Corrunized," etc., are welded, it is necessary to constantly break up the formation of such coatings on the welding electrode surfaces. This is done best by knurled rolls and almost always necessitates welding rolls below the strip as well as on top.

For highest production, lowest power demand, ruggedness, and simplicity of appearance and maintenance, the type of welder shown by Figure 4 and Figure 5 is distinctly preferred. The strip can be of any width desired within the particular machine clearances involved and have no effect on the electrical characteristics of the welder since the strip is not within the magnetic loop. This means no current variation as the welding head proceeds across the strip width.

Referring to Figure 5, it will be noted that the electrical circuit consists of a transformer mounted on a carriage running on steel rails, such transformer being connected to two welding electrode rolls operated by individual pressure cylinders, such electrodes completing the circuit through two welds in series and an insulated short circuiting platen beneath the strip.

The welding rolls are spaced approximately 5 in. with

Figure 5 — Same machine as in Figure 4, but with guard covers removed.



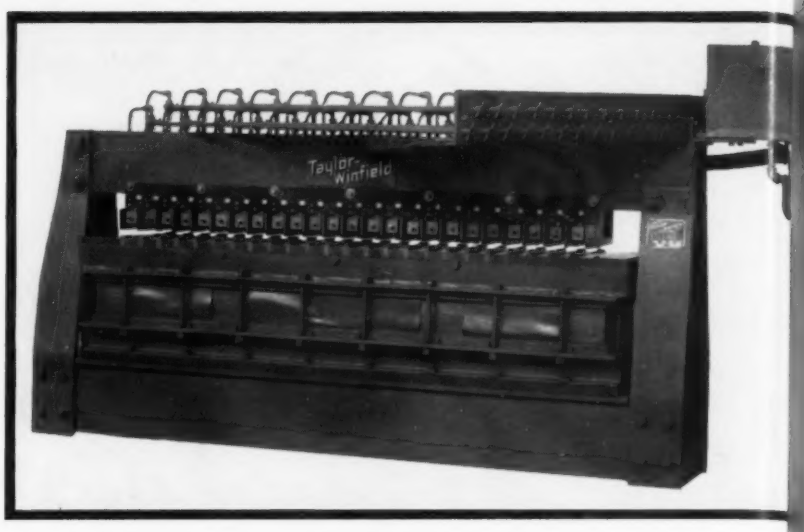


Figure 6 — Multiple electrode spot welder.

a clamping beam between the rolls. The welder is equipped with a set of strip carrying rolls and a weld locating stop bar.

When it is desired to make a weld, the tail end of the preceding coil is run through to its proper location and the stop bar clamped on the strip. The head end of the succeeding coil is run up against the stop bar which locates its end very close to the line of the first electrode. This causes the first weld to be near the leading edge of the joint and so prevent loose edges from catching in further processing equipment. The center clamp beam then clamps the head end in place. When the controls are energized, the two welding rolls contact the strip and proceed across the strip making intermittent welds. The welding current flows from one transformer terminal through one electrode roll, through one weld, through the short circuiting die beneath the strip, through the other weld, other roll and back to the transformer, thus making two series welds 5 in. apart. Such a circuit is not only very efficient from a power standpoint, but also doubles the weld production by making two rows of welds at once. The welder may be operated with the carriage traveling either toward or away from the operator. In some cases the welder has a squaring shear mounted on the incoming side of the welder to quickly prepare the oncoming end for welding.

Data for welding certain gauges of steel is given in Table I.

In a few special applications where the width and gauge of the strip is not constantly changing and where the welding time is short, multi-electrode welders are used.

Figure 6 shows a welder typical of such a design. A transformer or transformers are connected to each of a number of welding electrodes, each electrode having its own pressure system. While all welds could be made simultaneously by passing current through all electrodes at once, this is almost never done due to high power demand. Instead, one of two methods is usually followed.

One method which usually goes by the name of the

TABLE I

Welding Data

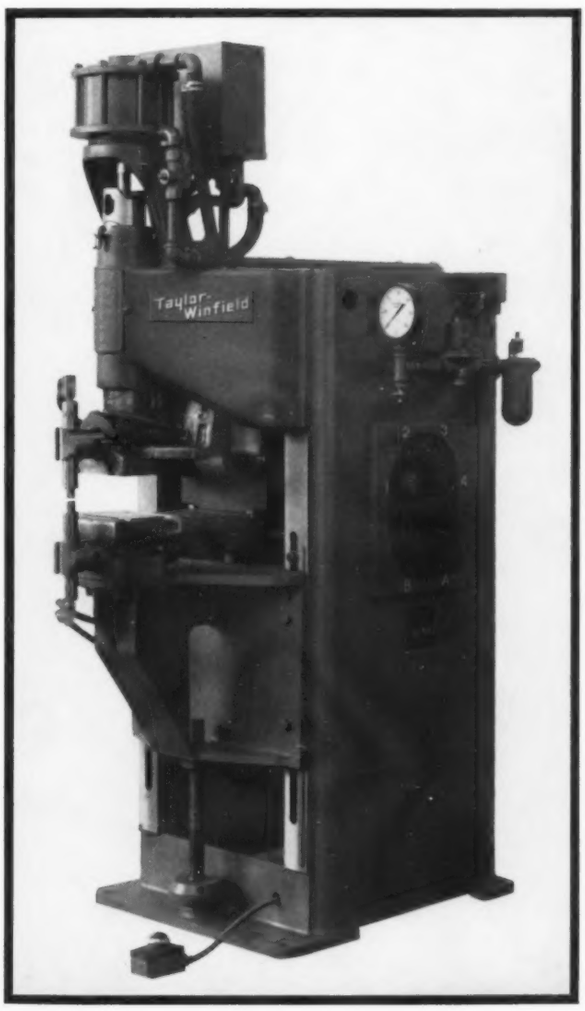
Material welded, C.R.S.	Welding speed, in. per min	Welding current, amperes	Welding pressure, pounds	Welding timing, cycles	Power demand, kva	Welding roll face, in.
2 pieces — 0.010 in.	360	12,000	1000	8 on — 8 off	75.0	¼
2 pieces — 0.025 in.	324	16,000	1100	8 on — 8 off	125.0	¼
2 pieces — 0.038 in.	252	17,000	1280	6 on — 8 off	145.0	¼
2 pieces — 0.062 in.	120	20,000	1350	9 on — 20 off	195.0	¼

hydromatic principle, has only one electrode contacting the strip at a time. The strip is clamped in place and a combination hydraulic distributing valve and timer causes each electrode in rapid sequence to contact the work, weld and retract. During the welding period, the primary of the transformer is energized, but only the contacting electrode carrys current, as the other electrodes are open circuited.

The other method is usually called the "ultra-speed" principle, and by its use, all of the electrodes contact the strip at once under pressure, but only one electrode carrys the current at a time. The connections to the electrodes in the transformer secondary circuit all pass through a commutating device, which connects the transformer to each electrode in turn and simultaneously energizes the transformer primary. Again current flows in only one electrode as the other electrodes are open circuited.

Such a discussion of spot welding in the processing of strip would be very incomplete without including the use of standard spot welders as shown in Figure 7. This type of welder performs excellent service in such applications as spot welding coils together ahead of a strand pickler. This type of welder will operate on a 20 turn weekly basis, month in and month out, welding up to a maximum gauge of 2 pieces of .250 in. strip steel. Unless the welder is mounted on a movable base, it is necessary to carry the strip to the welder. This is to be preferred, but is not essential under certain circumstances. Dressing of electrode tips is about the only maintenance required.

Figure 7 — Standard heavy duty press type spot welder.



If we shift our attention from the making of lap welds and give consideration to making butt welds, we then deal with a process which has no equal in making a joint of highest quality. This is borne out by the fact that after giving consideration to other methods of welding, such as arc, gas, etc., the governmental aviation agencies, such as the C.A.A., etc., give a design efficiency of 100 per cent to resistance flash welding, which is given to no other process.

Inherent in the flash welding process is a time cycle, which cannot be equalled by any other welding process. If it is desired to weld together two pieces of strip 80 in. wide, the welding time is no greater than if they are only 8 in. wide assuming the same thickness in both pieces. However, if it is desired to weld wide strip by such processes as the metallic arc, carbon arc, hydrogen atomic, arc, gas flame, etc., the time of welding increases in proportion to the width.

In production the arc or gas processes have a factor of gas inclusions in the deposited metal which is not present in a flash welded joint.

If we analyze the requirements of a flash welder in terms of what takes place at the weld, we may list the

following factors: (1) a proper start of the flashing action; (2) the "flashing-off" or burning away of a sufficient amount of metal for the particular gauge of strip under consideration at an optimum rate and optimum welding voltage and current; (3) a speedy and powerful "upset" or forging action of proper magnitude. Figure 8 shows a very common type of motor-operated welder which will handle strip up to a maximum section of ⅛ in. x 4 in. This type of welder has been quite successful in the automotive field and has operated in production in this field at a rate as high as 600 welds per hr.

The motor-operated type of welder built in this country is almost universally irreversible in sequence; i.e., once the machine cycle is started, the motor, through a gear reduction and cam, pushes the ends of the strip together, flashes off an amount as determined by the cam and upsets the ends together by means of a bump on the cam. It is this irreversible feature which dictates in many cases that the strip ends be sheared on the bias to offer point contact and facilitate easy starting of the flashing arc. The amount of material flashed off is determined by the rise in the cam from the starting to the upset points. These cams must be very carefully generated to a shape as dictated by the flashing rate of the section welded at a given speed, current and voltage. In apparatus handling heavy sections these cams must be quite massive so as to transmit high upset pressures properly. The upset bump is generally a hardened insert set in the cam at the proper place and shimmed to sufficient height to give the correct dimension of upset required for the section welded. Speed of flashing is variable within limits by means of adjustable pulleys or gearing.

A factor which should be kept in mind when selecting a proper drive for a flash welder is the speed of upset. This should always be as fast as possible. The motor-driven type of welder, by its very nature, slows down the speed of upset as the rotational speed of the cam is reduced when lengthening flashing time. In many applications this change of upset speed is not of great importance as welds are not subjected to great strain. In other cases it is of importance to obtain highest quality welds. The hydraulic type of control has speed of upset always at its maximum and independent of speed of flashing. Operating departments familiar with flash welds notice this difference as manifested by a larger swelling of upset metal when using motor drives and consequent greater maintenance of trimmer knives. Welding voltage is usually adjusted by means of taps in the welding transformer primary.

Figure 8 — Small size of motor operated welder capable of ⅛ in. x 4 in. maximum strip section.

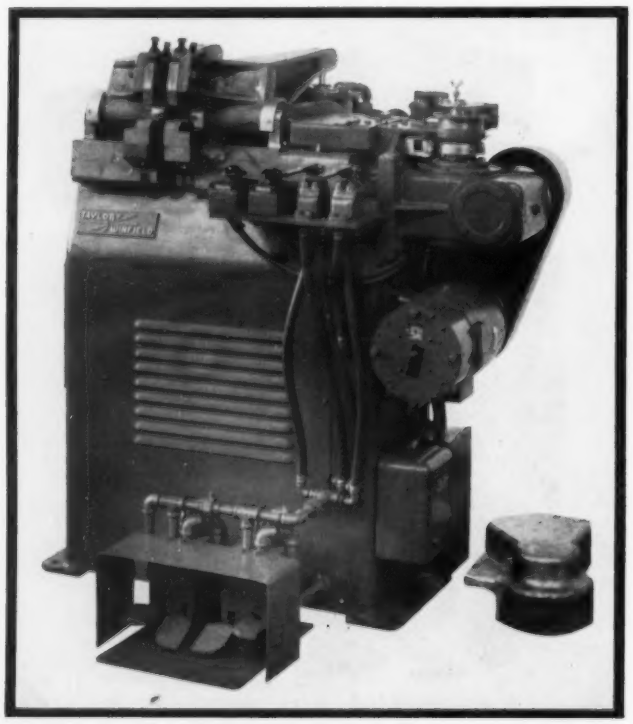


Figure 9 presents a view of a hydraulic type of welder designed specifically for steel mill strip welding. Essentially such a welder has a movable slide or platen actuated by one or more hydraulic cylinders. One end of a coil of strip is clamped on the stationary die and the matching end to be welded to it is clamped on the movable die. A hydraulic pumping unit delivers high-pressure oil to the actuating cylinder to cause the slide to move a controlled dimension at a controlled variable rate. The heart of this type of welder is the valving mechanism controlling the oil to the slide cylinder. The valve proper permits very sensitive control of the cylinder oil. This valve is actuated by a lever which first brings the projecting strip edges in just enough contact to start proper flashing, and, second, moves the slide at a predetermined adjustable rate and adjustable dimension by means of an automatic line cam. The action is reversible at any time and is so used to get a proper flashing start if necessary. Strip edges may contact squarely or otherwise, it matters little. No special precaution of bias shearing is required nor is there the danger of the starting arc "stumbling" or "plugging." Inasmuch as strip welding of mixed production requires a machine capable of rapid changes over a wide range of welded sections, the hydraulic type is particularly adaptable. The welder shown in Figure 9 will weld from 3/16 in. x 40 in. sections to 0.050 in. x 5 in. sections.

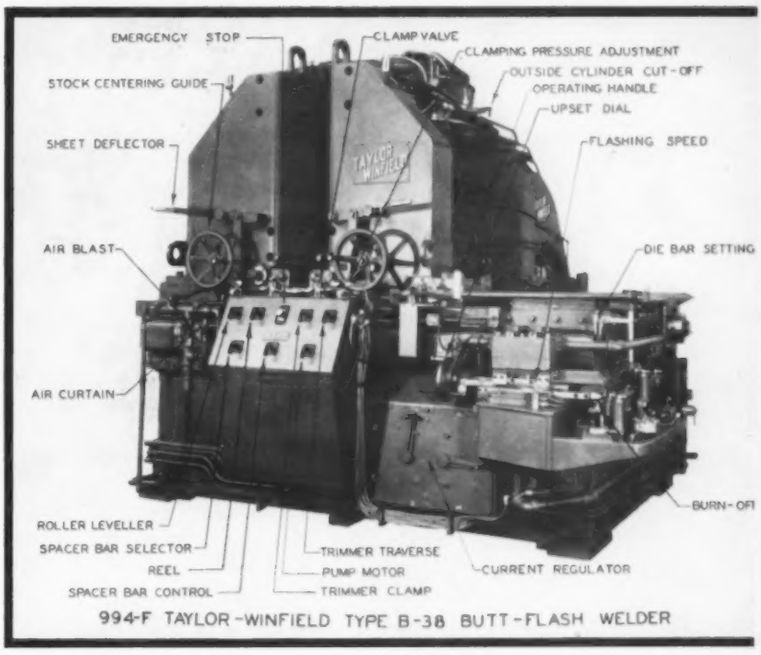
The speed of flashing may be varied by a calibrated vernier needle valve from 4 to 40 seconds. The amount of metal flashed off is readily controlled by a small line cam adjusted with a micrometer screw. This eliminates the changing of bulky rotary cams of variable shape. The amount of upset is controllable over a wide range by means of a calibrated hand wheel. The speed of upset is of the order of 400 in. per min. Such a high speed is obtained by throwing open the control valve automatically and absorbing the full output of an air-operated oil accumulator. Two auxiliary controls determine the amount of strip initially projecting from the dies and the final closed die dimension. A rotary regulator permits selection of proper secondary voltage through a tapped transformer primary. Hydraulic pressure regulators vary clamping pressure for varying strip dimensions on strip. A complete change of controls can be made within 90 sec. Presuming the ends of the strip are sheared, the weld may be made and trimmed in approximately 90 sec. The welder and trimmer bench boards should have strip controls providing inching

speeds to accurately locate the strip ends or weld in the welder and trimmer.

The trimming of the weld flash may be done by several designs of trimmer with varying degrees of success. A quality trimmer is one which consistently trims the flash off from about 0.002 in. above to 0.002 in. below the surface of the strip. Uniformity of trim is important as a trimmer which does not follow the strip variations will trim either too high or too low, and so result in a poor weld for cold reduction.

The best weld is obtained when the trimmed surface is flush with the strip surface or slightly below the surface. Reasons for this are threefold:

1. It is important that the hard flash above the surface be removed because it is detrimental to the highly polished surface of the cold-reduction rolls.
2. The hard flash above the surface is forced down into the relatively ductile strip section during cold rolling and has a tendency to "pinch" the strip and cause a fracture.
3. The material above the surface acts as a "bump" for the rolls to strike and so cause several feet of off-gauge strip and throw an unnecessary strain on the strip and weld. In some cases attempts have been made to overcome this trouble by slowing down the cold-reduction mill momentarily when the weld passes through. This in itself creates some off-gauge material. It is not necessary if welds are properly trimmed.



994-F TAYLOR-WINFIELD TYPE B-38 BUTT-FLASH WELDER

Figure 9 — Hydraulically operated steel mill type flash welder with capacity range from .050 in. x 5 in. up to 3/16 in. x 40 in.

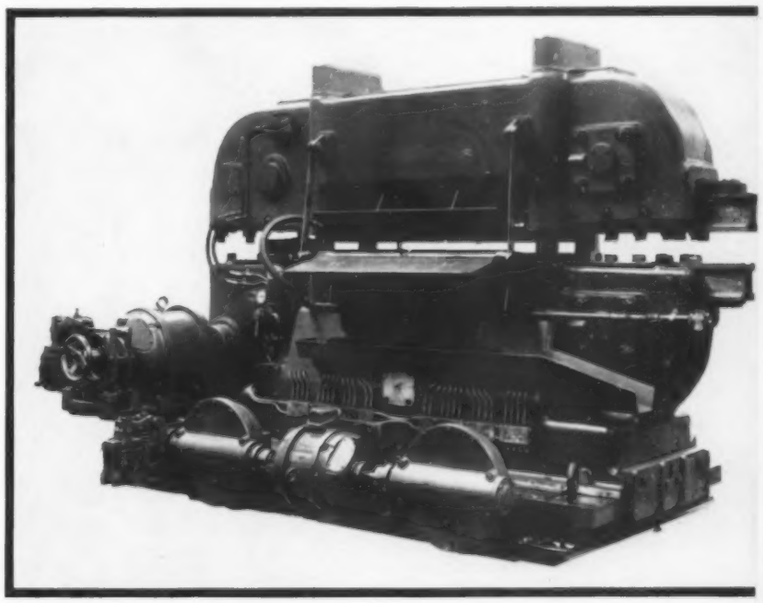


Figure 10 — Heavy duty mechanically driven draw cut, flash trimmer, which works on shaper principle, with five adjustable trimmer knives in each cutter ram.

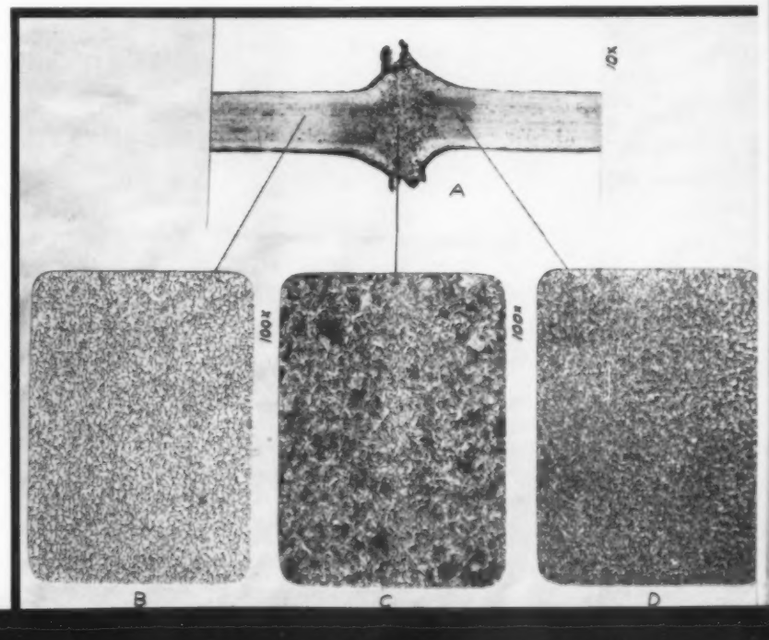


Figure 11 — Photomicrograph of resistance flash weld in .076 in. thick, .06 per cent C, .30 per cent manganese, A-1 deep drawing steel, etched with 3 per cent Nital. Note narrow band of forged, fine grained steel in center of C and grain refinement in heat affected zone as shown by D. Original parent material is shown by B.

Many welds trimmed slightly below the strip surface have been cold reduced in production with the mill running at full speed. Contrary to first thought, the strength of the section is not reduced below that of the rest of the strip. The slight increase of weld hardness over strip hardness is accompanied by an increase of tensile strength and competent metallurgists claim the welded section of a properly made weld could be reduced to 90 per cent of the strip thickness and still have a strength equal to the rest of the strip.

The more quickly the weld is trimmed the more smooth the surface will be after trimming. This is because the metal is cut red hot. The trimmer should be located as close to the welder as possible and controls arranged to facilitate this trimming as quickly as possible after welding. Trimming dry is preferred with stellite

tipped cutters. This also avoids rapid removal of heat from the weld by the use of a cutting lubricant.

For best production, the automatic type of trimmer which clamps the strip, trims and unclamps in an automatic sequence is to be preferred. Both hydraulically and mechanically operated trimmers give good results. An equalizing set of clamps which compensate for the variations of strip thickness from one side of the weld to the other is of distinct advantage. Not only does it make a more uniform trim but bevels the weld from the thick to thin strip. Figure 10 shows a typical mechanically operated trimmer.

A typical question is how good is the weld and how do welder variables affect it? The final answer in most installations as to quality lies in the capability of the weld to undergo cold reduction. Sometimes this means reduction to sheet stock and sometimes to tin-plate stock. A typical reduction for tin plate is cold rolling from 0.076 in. thickness to 0.009 in. or 0.010 in. in a single-stand reversing or 5-stand tandem mill. All measurements of hardness, tensile strength, ductility, etc., may be used as yardsticks of comparison if properly interpreted. In the following discussion of weld characteristics it should be noted that we refer to very low carbon (approximately 0.06 per cent, 0.30 per cent manganese) A-1 deep-drawing strip steel just off the hot mill. Higher carbon content, high silicon alloys, heat treatment, etc., change the whole picture of welding technique and weld characteristics.

Figure 11 shows the metallurgical structure of a typical flash weld in tin plate stock. Table II indicates how the strip material hardness changes due to welding.

Table III is a tabulation of tensile tests made of flash welded steel strip.

If the foregoing discussion of flash welding was analyzed without any comments on operational problems, the usual reaction would be that it sounds too good to be true and this reaction would be correct.

There are few operations in processing which pay greater dividends than a good application of a butt flash welder to make as large coils as can be handled.

On the other hand, there is practically no process which can be a greater operational headache than a poor flash welding installation. Whether or not a flash welding installation is a success depends largely on the attitude of the operational management. If the management forgets any preconceived notions of welding as being a rough and ready process and recognizes that the installation is just as much a precision process as

TABLE II

Hardness Differential of Weld Center and Strip

Strip thickness, inches	Hardness, Rockwell B, at various dimensions from weld center						Weld and strip differential
	0	1/16 in.	1/8 in.	1/4 in.	1/2 in.	1 in.	
0.053	76.5	71.0	69.0	65.0	64.3	62.7	13.8
0.117	71.0	69.2	64.8	62.3	57.6	57.5	13.5
0.180	87.5	84.9	80.8	75.5	75.3	74.2	13.3

TABLE III

Tensile Tests of Resistance Flash Welds of Low-Carbon Steel Strip

Thickness, in.	Strip width, in.	Area, sq. in.	Yield point, psi	Tensile strength, psi	Elongation, per cent in 1.75 in.	Distance from fracture to center of weld, in.	Condition of weld surface
0.0539	1.002	0.05403	40,240	53,360	15.2*	1.100	Flash and upset removed
0.0543	1.001	0.05437	41,050	53,470	15.8*	1.075	Flash and upset not removed
0.117	1.002	0.1173	37,820	48,650	16.3*	1.450	Flash and upset removed
0.117	0.999	0.1169	36,950	48,540	17.7*	1.500	Flash and upset not removed
0.1805	1.001	0.1809	38,910	64,250	13.2*	1.275	Flash and upset removed
0.1805	1.001	0.1809	39,030	63,690	13.8*	1.375	Flash and upset not removed

All elongations were measured across the weld. Each of the above figures represents the average test values of five specimens. Maximum and minimum values are consistently close to the average values.
*Twenty-nine of the thirty tested specimens broke outside the elongation marks.

cold reduction in a tandem mill, then that installation is almost sure to be a success.

It is obvious that if two pieces of 0.078 in. tinplate are welded together, and the welding dies are worn to an error in alignment of 0.008 in., then the finished weld is 10 per cent wrong, and this is too much.

A common error is to assume that the welder will be a compensator for cambered strip off the hot mill, heavy unbroken scale due to poorly adjusted processor rolls, poorly sheared strip ends due to worn shear knives, welds out of alignment due to poor maintenance of welder dies, and improper operation of the welder by incompetent operators drawing too low pay rates.

It is also true that some welders have been built which were not sufficiently rugged or were unnecessarily complicated or were not designed with the possibility of rapid adjustments and die changing in mind.

I am glad to be able to state that the welding equipment manufacturers are working to overcome these problems of welder design, and that the welders in common with other processing apparatus such as tandem mills, pickle lines, etc., are showing steady improvement.

The attitude of operational management and personnel toward the welding installation is also changing and the change is producing distinct gains in the quality of production.

If for no other reason than the stiff competition which many of us feel will follow the present emergency production, I look forward to a number of new butt welding installations in the next few years.

DISCUSSION

PRESENTED BY

H. W. NEBLETT, Development and New Design Engineer, Inland Steel Company, East Chicago, Indiana

H. H. SHAKELY, Master Mechanic, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

J. H. COOPER, Welding Engineer, The Taylor Winfield Corporation, Warren, Ohio

E. B. RESSLER, Strip Mill Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

J. A. REA, Service Engineer, Linde Air Products Company, Cleveland, Ohio

STANLEY GRAND-GIRARD, Electrical and Mechanical Superintendent, Sharon Steel Corporation, Sharon, Pennsylvania

C. H. JENNINGS, Research Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

H. W. NEBLETT: Mr. Cooper has given a very concise and accurate description of electric welding equipment for cold strip processing in its present state of development. He has described the various types of welding and pointed out the most advantageous equipment applicable to each type.

Probably, of all these, the one which is receiving the most attention from the steel companies at the present time is the resistance butt flash welding process. Mr. Cooper indicates quite clearly why this is to be expected. The butt flash welding process is applied almost entirely to the welding together of hot rolled strip to provide greater coil length. These coils are then further processed and reduced in thickness in cold rolling. The requirements of such a process are that the weld be able to withstand successive reduction in the cold mills as the strip is being reduced to very thin gauge. To meet these requirements necessitates a weld of the highest quality produced with extreme accuracy.

It is interesting to note the strides that have been made for this type of welding in the last few years. In 1935 Inland Steel Company installed their first electric butt flash welding machine on one of our wide strip pickling lines for welding wide and heavy gauge of rolled strip. This machine, with minor changes, is in operation today. The operating and engineering experience gained from this machine has contributed considerably to the development of the equipment offered today for butt flash welding of strip steel. The equipment available today embodies many improvements that materially assist in producing a weld that will withstand the severe service required.

While great strides have been made in the past few years, there are still other refinements and improvements desired which, no doubt, will be achieved in the future. Mr. Cooper states that the welding equipment manufacturers are fully aware of the problems involved and they are pursuing them to a satisfactory conclusion. My personal experience confirms this and I think we can now consider electric welding equipment as standard apparatus in flat rolled strip steel processing.

H. H. SHAKELY: I would like to ask Mr. Cooper a question. In the welding of strip steel which is to be reduced to tin plate gauges, have you had any good results in welding duplex steel? that is, steel made by duplex process. We have had very good results with straight open-hearth steel, but very questionable results with duplex steel. You mentioned a 15 point rise in Rockwell hardness, B scale. We get up to a 25 to 30 point rise in the weld. Our breakage, instead of being 2 or 3 per cent, where it should be, will go as high as 25 to 30 per cent. I wonder, if any of the companies has had the same experience, and I would like to know what was done to counteract it.

J. H. COOPER: That 15 point Rockwell B scale rise was based only on .06 per cent carbon deep drawing steel, and is in no sense of the word indicative of what you get with duplex or any other materials. For instance, when welding .40 per cent carbon, it is almost imperative that it be annealed as quickly as you can get it trimmed. To accomplish that, in one application, I am thinking of, as soon as it comes out of the trimmer, a multiple flame torch goes across and anneals it. I don't believe they would have any success welding without this annealing, as .40 per cent carbon gets so brittle you can't even bend it around a twelve inch radius. After it is annealed, it takes quite a reduction. I am not surprised if you do get 35 per cent breakage.

H. H. SHAKELY: With this .40 per cent carbon, do you then reduce it after welding?

J. H. COOPER: In this welding operation it is not

cold reduced. It is sold as coils for auto parts stampings. While the service isn't comparable to cold reduction, nevertheless when a weld across a strip is bent and formed into channels, the sharp radius of the bend will cause a brittle weld to crack. This application isn't a perfect comparison with the cold reduction, so I haven't any comparable figures.

There is one comment which should be added to the remarks of Mr. Neblett, and that is the development of these welders has been due largely to the vision of the steel mills managements, who saw what they had to gain by using welded coils. Without exception, ten years ago, the welding manufacturers were men who made machines primarily for the automotive industry and practically none for the steel industry. When they started to designing steel mill apparatus, they found they were dealing with a different breed of cats. Apparatus had to be two or three times as strong as before, and work for long periods of operation without much maintenance. There were some sad experiences by everyone connected with the apparatus regardless of who made it. I am glad to say the steel mill management kept on demanding better equipment and the manufacturers played ball by doing all they could to meet such requirements. The problem isn't 100 per cent solved, but it is well on the way, and all indications are that it is going much farther.

E. B. RESSLER: May I ask Mr. Cooper a question with reference to this gas-annealing equipment? Can he tell us the type of equipment which was used in the application of which he spoke, and where the torch was located with reference to the trimmer?

J. H. COOPER: In this particular case, there was no device that carried the torch. The equipment consisted of an ordinary hand operated oxyacetylene torch with bottled gas, which was used to anneal the .40 per cent carbon strip at the weld in a recoiling line. As the weld came out of the trimmer, it was stopped between trimmer and tension roll. The operator moved the torch along the weld at a speed of approximately 48 in. per min. Moving at that speed and doing the heating as soon as possible after welding, and trimming, to take advantage of the welding heat, a streak of annealing heat some three or four inches wide was obtained, at a temperature approximately 700 to 800 F. This strip was approximately .095 in. thick and the three or four inch width of annealing heat was sufficient to anneal the brittle welded section.

Incidentally, if you cross-section a flash weld, you will find the only hard part is a little strip that is from $\frac{1}{32}$ in. to $\frac{1}{16}$ in. wide right through the middle of the weld. This zone is all you have to correct by annealing, and if you catch that, it is not necessary to go any father out in the strip from the weld. Using the mechanically operated annealing process, a photo-electric eye is used.

J. A. REA: I think I can add a bit of information on the process of oxyacetylene annealing welds. One of the mills in Cleveland is equipped to do it with multiple flame heads which don't move at all. It is purely a spot-heating proposition which takes seven seconds. The torch heads are water-cooled because of the severity of the heat. It accomplishes essentially what Mr. Cooper has described without the necessity of anything but the turning on and off of a valve. There is no manipulation whatever.

STANLEY GRAND-GIRARD: May I ask if the method of opening the clamps, reclamping with a greater opening between dies, and then electrically applying heat from the welder can be used, or is it practical?

J. H. COOPER: The answer to that is yes and no. For instance, Mr. Ressler and any of the personnel that happen to be connected with the Jones & Laughlin rod mill, know they have a number of welders there for rods, the operating cycle being such that immediately at the conclusion of the weld, the rod is unclamped, the clamps separated, exposing two or three inches between the dies, the dies reclamped, the annealing contactor energized, which sequence causes the use of a lower current for annealing than is used for the flash welding. Such welded rod takes a great deal of drastic cold reduction. This is true not only on low carbon steel, but all the different alloy rods they put through the line.

If we desire the annealing of strip, where the section is compact, such as a quarter of an inch thick and four inches wide, the answer is yes, it can be done. However, if we desire to anneal welded strip .076 in. thick and 30 in. wide, the answer is no, because we get hot spots. There is no assurance that the die contact resistance will permit an even distribution of current along the weld across the 30 in. width, and in all experimental work on strip of such width, we get a succession of hot spots which will consist of several spots two or three inches long, which will get so hot that the metal may drop through, while adjacent to these spots will be spots which are so unheated as to show no color. Such a variation is purely a matter of the degree of consistency of contact, and the advisability of annealing in the welder may have an answer that in some cases it can be done, but in other cases, it cannot be done, but when we refer directly to the type of welds covered in this paper, the answer is no.

I think the gas-flame annealing process is the best answer to date. The heating can take place, depending on the application, in several places. By far the better place is to have it take place after trimming. If we trim just as quickly as possible after welding, we are going to get a service period without much maintenance, that is much better on your trimmer knives and produces a much better trim. If a weld comes from the trimmer blue, having been trimmed red hot, an excellent slick trim free from chatter marks, and higher degree of uniformity will be obtained than if you let it get cold. After trimming, is the proper time to anneal.

C. H. JENNINGS: Mr. Cooper is to be complimented on his brief but very instructive analysis of the various types of resistance welding equipment employed to join strip in connection with cold strip processing. The comments on flash welding have been particularly instructive because I have had a little experience in trying to adjust this process so that the joint did not fail during the cold rolling operation.

Two factors are known to influence the breakage of flash-welded joints during the rolling process — (1) high hardness of the weld, and (2) unsound welds. Mr. Cooper has touched on the question of hardness and mentioned the need for proper flush trimming. This

(*Please turn to page 74*)

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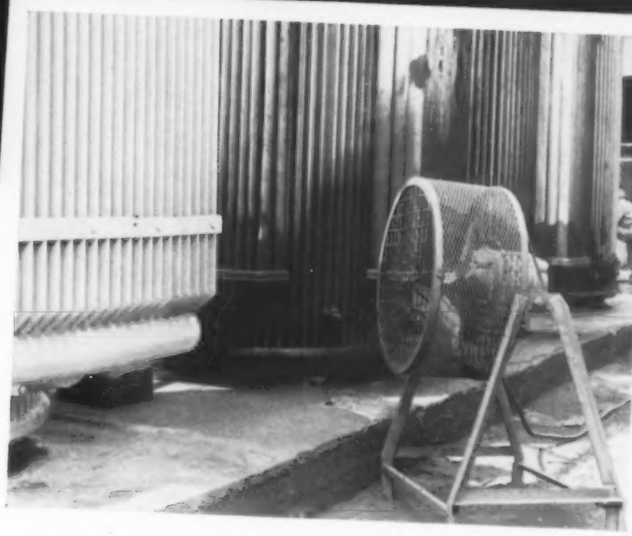

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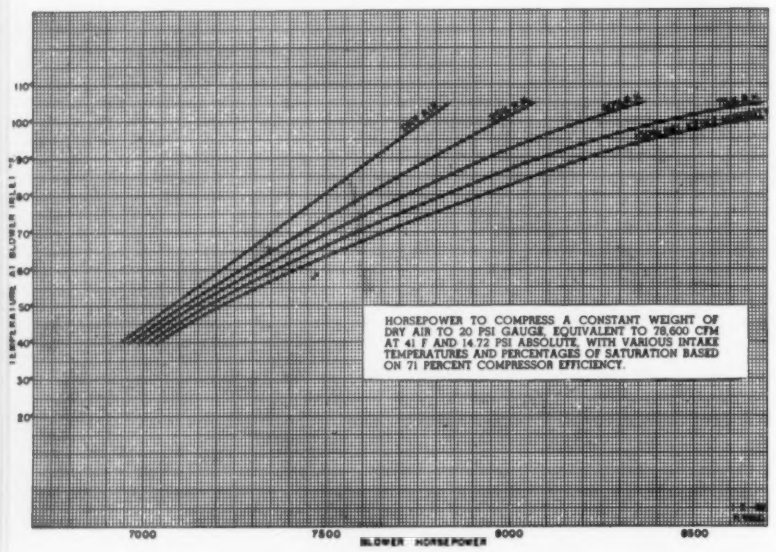

Figure 1 — Curves showing power requirements to compress air under varying conditions.

Economic Aspects

By R. VD. Dunne

Industrial Engineer

CARRIER CORPORATION

Syracuse, New York

Presented at

A. I. S. E. DETROIT DISTRICT SECTION

▲ DURING times of war, and particularly in the mechanized warfare of today, both industry and individuals are placed under tremendous pressure in the ever-increasing demand for more and more production. The heavy industries are especially burdened with responsibility for they are charged with producing the basic materials with which modern war is waged. The steel industry is universally recognized as a — if not the — major basic heavy industry and theirs is the problem of supplying steel for tanks, guns, engines, and ships as well as the steel for machines and structures for manufacturing these implements of war.

The steel industry has done and is doing its job well. Evidence of this is apparent from published figures of production too well known to bear repetition.

Even the investments in plant equipment and the technological advancements made during the depression years have not proved sufficient to meet the needs of the armament program and the curtailed civilian requirements. The cry is for increased production and we are all united in subscribing to the maxim that it is better to have too much too early rather than too little too late.

There are, of course, many methods of providing for an increase in iron production. New furnaces may be built and old ones modernized; ore grading, sintering and many other means may be used. Additions or improvements of this nature, however, involve the expenditure of hundreds of thousands or even millions of dollars in capital investment; the utilization of steel urgently needed for armament; and delays of weeks and months. It is reasonable, even in these days, to question the economic aspects of plant expansion with large capital outlay in regard to the conditions that will exist after this present war is over. The analysis of our post war economy is a real problem that is being given increasing study and attention by both management and government and any degree of change in the world or domestic economic structure will have a proportional or even greater effect upon a basic industry such as steel.

It is, therefore, desirable that other avenues be explored which will provide ways and means of producing more pig iron more quickly and at a smaller investment. It is here that air conditioning or dry blast for blast furnaces receives consideration.

At the turn of the century, the Gayley plants proved that dry blast would increase pig iron production and provide a complementary decrease in coke consumption. These plants, now long out of service, are recognized in the light of modern air conditioning equipment as being exceedingly high in initial investment and operating cost; unwieldy and space consuming; and all were dismantled, as the necessity for costly repair and replacement increased. It was not until 1939, some twenty to twenty-five years after the last of the Gayley plants, that air conditioning was again experimented with. The word "experimented" is used advisedly.

This first modern plant was installed in the south and less than a year later a second and practically identical system was purchased for the same plant and a third followed shortly thereafter. This is striking evidence that the "experiment" was a success.

In 1941 a northern furnace decided to "experiment" and as a result three furnaces were equipped with dry blast. Other installations followed and the value of pre-compression refrigerated dry blast was acknowledged as far away as India where a dry blast plant will be installed as soon as the equipment arrives there.

In brief, air conditioning for blast furnaces has already justified its existence and has proved that it can be a powerful factor in driving a furnace to consistently higher production levels more economically and with appreciable savings in coke. It is no longer an experiment.

There is, however, a major plus value in addition to increased production and lower coke consumption that has not been given sufficient recognition thus far in the analysis of pre-compression refrigerated dry blast. The purchase of any equipment must eventually meet the rigid test of economic justification in peace time as well as war. The pre-compression chilled water spray type

# of Pre-Compression Refrigerated Dry Blast

dry blast system passes this test in both theory and practice. This type of system, however, does more than justify itself in that the cost of operating services such as steam and power is either a stand-off or results in actual dollar savings.

In order to demonstrate this plus value in respect to operating costs and capital charges, it is necessary to refer to fundamental gas laws and psychrometric data and to provide a basis of operation with which the dollar and cents economics may be evaluated.

To provide an example for analysis, the area of Cleveland has been selected as typical of the weather conditions encountered in northern practice. A furnace requiring 80,000 cfm of wind at 60 F and 14.72 psi absolute (29.92 in. of mercury, barometer) is used. The air is to be reduced to 3 grains (approximately 41 F saturated) and blast pressure is normally maintained at 20 psi gauge. Steam for driving the turbine for the centrifugal refrigerating machine and the turbo-compressor is available at 400 psi pressure and 700 F total temperature.

As the volume of a given weight of any gas at constant temperature varies in direct proportion to its absolute temperature, the volume of standard air is expressed as:

$$V=\frac{WRT}{P}=\frac{53.3 \times (460+60)}{14.72 \times 144}=13.07 \text{ cu ft per lb of dry air}$$

The furnace operator is concerned with lb of air supplied to the furnace rather than cu ft and therefore there are $80{,}000 \div 13.07 = 6125$ lb of dry air required.

As air at 41 F saturated contains 38 grains of moisture per lb of dry air, it is necessary to compensate for this moisture thus:

$$6125\left(1+\frac{38}{7000}\right)=6158 \text{ lb per minute, air plus water vapor}$$

This air quantity must again be compensated for by the determination of the actual cu ft per lb at the condition of 41 F and 38 grains entering the blower. This may be most simply determined from the following formula:

$$V=\frac{.755\ (t+460)}{P}\left[1+\frac{W}{4360}\right]$$

where: V = the volume of 1 lb of dry air with contained moisture
t = the dry bulb temperature, F
P = the barometric pressure in in. of mercury
W = grains of moisture per lb of dry air as obtained from the psychrometric chart and table of barometric corrections

As we are not presently concerned with other than standard barometric pressure, we may substitute directly:

$$V=\frac{.755\ (460+41)}{29.92}\left[1+\frac{38}{4360}\right]=12.76 \text{ cu ft per lb}$$

It is therefore necessary to provide 6158×12.76 or 78,600 cfm at 41 F for furnace operation.

Account must be taken of the friction added to the suction side of the blower by the air conditioning apparatus. With proper design of the spray type dehumidifier suitable for the purpose this friction amounts to 2 in. water column and places the total pressure ratio at:

$$\frac{P_2}{P_1}=\frac{34.72}{14.72-\dfrac{2}{12\times 2.31}}=2.36$$

It is then necessary to calculate the gas constant, R:

$$\text{Mol. wt.}=\frac{1544T}{PV}=\frac{1544\times 501}{14.72\times 144\times 12.76}=28.6$$

$$R=\frac{1544}{28.6}=54.00$$

With these values determined, substitutions are made in the basic formula to obtain the horsepower requirements for air entering the blower at varying conditions of temperature and humidity.

$$\text{H.P.}=\frac{\dfrac{n}{n-1}\ WRT\left[\left(\dfrac{P_2}{P_1}\right)^{\frac{n-1}{n}}-1\right]}{33{,}000\times \text{per cent efficiency}}$$

where: n = exponent of compression curve (1.40 for adiabatic)
P_1 = entering air pressure in psi absolute
P_2 = discharge air pressure in psi absolute
W = weight of air
R = gas constant
T = entering air temperature, F absolute

Figure 1 indicates the horsepower requirements for air entering the turbo-compressor at various temperatures and relative humidities.

An inspection of weather data was made for the Cleveland area as being representative of northern operation. These data were obtained from the meteorological bureau and are less favorable to the analysis than readings taken in the area surrounding a blast furnace. Test and observation have shown that the wet bulb and dry bulb temperatures of the air in the vicinity of a furnace will average from two to five

degrees higher than readings taken at airports or government weather bureau stations. This analysis may be translated into actual steam and electric requirements for the dry blast system.

A review of meteorological data immediately proves that simple monthly or even weekly assumed averages will not provide a basis of sufficient accuracy for a worthwhile study of operating costs. The possibility of human error in such assumptions and its effect upon the calculations is too great to permit of any analysis other than the laborious use of daily averages of dry bulb and wet bulb temperatures or relative humidity readings. The same care must be exercised in the determination of refrigeration tonnage requirements, turbine water rates and condenser water temperatures. Table I summarizes the monthly demand for steam, power and water.

It is evident that there is an actual saving of 636,600 lb of steam per year in turbo-compressor consumption, due to the low temperature air entering the blower.

It is also recognized that there will be a heat deficiency in the air entering the stoves amounting to a maximum of 3070 million Btu in the peak summer month and 12,724 million Btu in one year. It is interesting to note that with a ratio of 5.679 gross tons of gas to 3.967 gross tons of air blast per gross ton of pig iron this total Btu deficiency amounts to less than .7 of 1 per cent of the total gas output of the furnace for the year. Stove heat has been charged at 5 cents per million Btu.

Power for driving the chilled water pumps amounts to 536,994 kwhr per year. Electric current is valued at 5 mills per kwhr.

The cost of condenser water for the centrifugal refrigerating machine has been evaluated at a cost of $4.00 per million gallons. It is recognized that this charge is a difficult one to determine and properly apportion as this water may be re-used in many places in a steel mill. The charge includes the cost of pumping, maintenance of lines and strainers, and the amortization of the initial investment.

A summary of estimated cost of steam and power services based on composite costs for these services is:

Steam — 636.6×.20=$1273 saving

Stove heat — 12,724.4×.05=	$ 636
Power — 536,994×.005=	1685
Condenser water — 588.6×4.00=	2354
	$4675
Less steam saving	1273
Total service cost	$3402

Assuming this to be a 1000 ton furnace, and dry blast provides a 10 per cent increase in production, this cost of services amounts to 8.4 mills per ton of pig iron produced by the furnace.

It is significant that for each 1 per cent decrease in coke consumption which is realized, assuming the ratio of .965 gross tons of coke per ton of iron produced, there will be 4000 tons of coke saved which, at $5.00 per ton, represents a saving of $20,000 per year.

No attempt is made to evaluate the increase in dollar value of the 10 per cent or more increase in pig production as the cost of ore and limestone and the handling of these materials varies to a considerable degree. However, some appreciation of the magnitude of the value of this extra production is apparent when considering that the average price of pig iron is $23.61 per ton and the composite price of the finished steel product is $50 to $55 per ton.

Further costs must be considered. Assuming that the typical 80,000 cfm steam turbine driven dry blast plant

TABLE I

Month	M lb of steam for rehumidification	Lb of steam for refrigeration	M lb of steam for turbo-blower with dry blast	Total lb of steam for dry blast	M lb of steam for turbo-blower without dry blast	Difference	Heat of compression, M Btu, deficiency and surplus	Kilowatt hr for pumps	M gallons condenser water
Jan.	1,493	24,000	42,935	44,452,000	41,731	+2,721,000	+ 1,115,660	22,865	1,678
Feb.	877	186,240	38,780	39,843,240	38,180	+1,663,240	+ 573,060	27,760	11,743
Mar.	540	509,240	42,935	43,984,240	43,216	+ 768,240	− 322,910	40,340	31,219
Apr.	338	625,200	41,550	42,513,200	42,402	+ 111,200	− 837,340	41,969	40,176
May	27	1,122,820	42,935	44,084,820	46,798	−2,713,180	− 1,697,090	55,490	72,871
June	.....	2,034,240	41,550	43,584,240	44,340	− 755,760	− 2,433,700	55,950	83,550
July	.....	2,857,920	42,935	45,792,920	46,695	− 902,080	− 3,019,900	57,820	86,335
Aug.	.....	3,023,100	42,935	45,958,100	46,670	− 711,900	− 3,070,400	57,820	86,335
Sept.	.....	1,817,280	41,550	43,367,280	46,015	−2,647,720	− 1,950,700	57,820	75,384
Oct.	42	960,680	42,935	43,937,680	44,477	− 539,320	− 1,413,040	56,650	66,960
Nov.	493	403,680	41,550	42,446,680	42,000	+ 446,680	− 417,800	37,310	27,316
Dec.	1,097	72,000	42,935	44,104,000	42,181	+1,923,000	+ 749,450	25,200	5,033
Total	4,900	13,636,400	505,525	524,068,400	524,705	− 636,600	−12,724,440	536,994	588,600

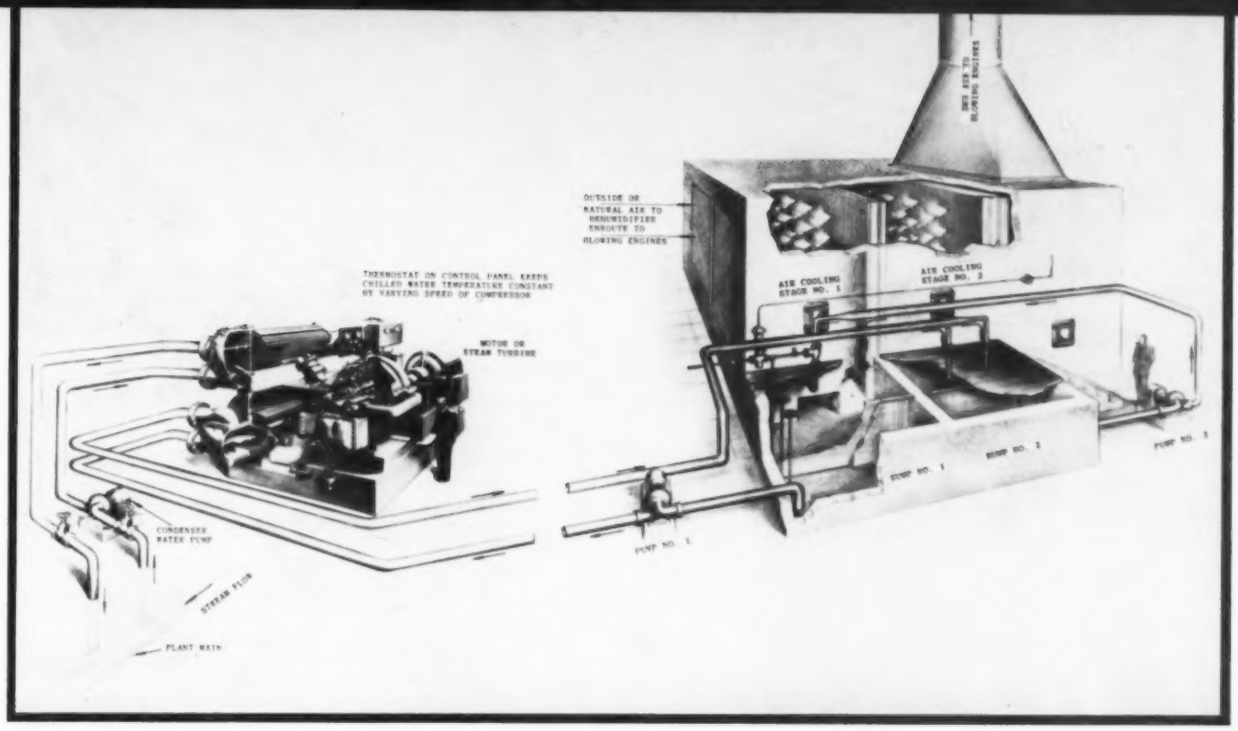
OUTSIDE OR NATURAL AIR TO DEHUMIDIFIER ENROUTE TO BLOWING ENGINES
AIR COOLING STAGE NO. 1
AIR COOLING STAGE NO. 2
THERMOSTAT ON CONTROL PANEL KEEPS CHILLED WATER TEMPERATURE CONSTANT BY VARYING SPEED OF COMPRESSOR
MOTOR OR STEAM TURBINE
CONDENSER WATER PUMP
STEAM FLUE
PLANT MAIN
PUMP NO. 1
PUMP NO. 2
PUMP NO. 3

Figure 2 — Sketch showing general arrangement of blast conditioning installation.

requires a capital investment of $140,000 and may be amortized in five years, there will be a principal payment of $28,000 per year and an average interest charge of $3,360 per year at 4 per cent. This yearly payment at $31,360 plus service charges of $3400 represent only one-third of the coke savings realized if the conservative estimate of 5 per cent saving is used. In actual experience in one plant the combination of increased production, saving in coke together with the negligible operating cost has already paid for the investment in eighteen months.

Further advantage is gained from the fact that the amount of steel used for the pre-compression refrigerated dry blast plant is considerably less than one day's increased production provided by the dry blast plant. In one plant the mechanical equipment for dry blast required less than 35 tons of metal and the system enabled the furnace to produce more than 115 tons of iron per day in excess of its normal capacity. Therefore the diversion of iron and steel from defense needs is negligible.

The operating costs as given above have proved to be conservative in practice. Mr. Berg, president of Woodward Iron Company, has stated: "The cost of operation of air conditioning equipment has been extremely low, and the increase in steam consumption has been only that required for the increased quantity of air possible to be blown on our furnaces since air conditioning."

E. K. Miller, assistant general superintendent of the Aliquippa works of the Jones & Laughlin Steel Corporation reported at a recent meeting of Blast Furnace and Coke Oven Associations that: "For the first six months the amount of steam saved on the turbo-blower in operating No. 1 furnace on conditioned air was the equivalent of 2,900,000 kwhr. This, in turn, more than offset the operating cost of the air conditioning unit, after taking into account the loss of heat in the air entering the stoves which was at a lower temperature."

The value of the negligible operating cost will become increasingly apparent when we again operate on peacetime economy. The non-air conditioned furnace will not produce as much and as uniform iron as economically as the one equipped with pre-compression refrigerated dry blast; and it is recognized that any system which does not depress the temperature of the air before entering the blowing engine cannot hope to provide this economic operation during peacetime.

DISCUSSION

PRESENTED BY

J. A. CLAUSS, Chief Engineer, Great Lakes Steel Corporation, Ecorse, Michigan

R. VD. DUNNE, Industrial Engineer, Carrier Corporation, Syracuse, New York

L. L. LEWIS, Carrier Corporation, Syracuse, New York

W. J. REES, Mechanical Engineer, Great Lakes Steel Corporation, Detroit, Michigan

G. R. McDERMOTT, Vice President, Chapman-Stein Division, Surface Combustion, Toledo, Ohio

J. A. CLAUSS: The problem of conditioning the air for blast furnaces is at present receiving a great deal of attention because by some it has been claimed that conditioning the air for a blast furnace will increase its production of pig iron 10 per cent and reduce the coke per ton of iron 8 per cent. There are a good many able practical operating blast furnace men and engineers who disagree with the above statement. Frankly I don't know, nor do I think anybody else knows, how beneficial air conditioning is in blast furnace operations. I say this even though there are at present three outstanding installations of blast furnace air conditioning units in operation today: one at the Woodward Iron

Company's furnaces at Woodward, Alabama; and one each at the Jones & Laughlin Aliquippa and Pittsburgh blast furnaces.

The climatic conditions between the northern and southern parts of this country are quite different. We know that in Alabama the humidity and therefore the moisture content of the air is considerably more than in Michigan. We also know that certain other improvements along with air conditioning were made at the Woodward Iron Company and we, therefore, do not accept without question the claims made for the air conditioning units at those furnaces. No doubt as the result of furnace improvement and conditioning of the ore, plus air conditioning plus greater interest and closer attention to detailed furnace operation there has been at these furnaces considerable improvement in furnace practice resulting in increased production and less coke consumption. How much of this improvement is directly due to air conditioning I question if anyone knows.

The air conditioning installation at the Aliquippa works of the Jones & Laughlin Steel Corporation has received wide publicity since E. K. Miller, assistant general superintendent at this plant, reported his findings after six months of operation.

At Great Lakes we have been following closely the development of blast furnace air conditioning for some time. As a result of our investigations and studies, last August we requested and were granted an appropriation to install an air conditioning unit on one of our furnaces at Zug Island. The installation is to be made for the purpose of determining under our own operating conditions whether there are any benefits to derive from air conditioning blast furnaces. In order to make a comparison we are going to arrange this equipment so that it can be installed to operate on either B or C furnaces. We will first try it out on C furnace and we will then be able to determine whether there has been any improvement in the operation of the furnace with air conditioning as compared with its previous records. By the time we have determined the conditions on C furnace, we will have acquired some experience on the new B furnace, and we can then use the equipment on B furnace to determine if there is any improvement with air conditioning.

National Steel Corporation is operating ten blast furnaces and it is important that we get the right answer. While our installation is experimental for the purpose of determining the corporation's future policy as regards air conditioning, it will be a full size unit and it is hoped that the installation will show enough improvement in furnace practice to justify the expenditures made on this and future installations.

There is much conflicting opinion as to how dry air should be conditioned for blast furnaces; some claim three grains of water per cubic foot and others claim one grain of water per cubic foot. Since we are primarily interested in getting the unbiased facts and our installation does not have to justify anyone's pet theory or claims, it was our considered opinion that an air conditioning system which would permit us to operate over the full range from one to three grains of moisture per cubic foot was the system we should install, and that is what we are doing.

In Detroit the grains of moisture per cubic foot of air varies from one-half grain to nine grains. From January to the middle of March it varies from one-half to about three grains, from the middle of March to about the middle of October it varies from about three to nine grains, from the middle of October to the end of December it varies again from three to one-half grains per cubic foot. The temperature of the water in the Detroit River at our Zug Island plant varies from 36 F in January to 76 F in August. It is because we have this excellent cooling water that we will be able to operate our proposed air conditioning unit six months on three grains, four months on two grains, and two months on one grain of moisture.

The plant we are going to install is what is nominally called a three-grain plant using Dow 8A solution for the absorption medium. It will be operated as noted previously. Should we determine that we wish to operate the plant twelve months of the year on one grain of moisture the Dow 8A solution will be changed to a Dow 17A solution by the addition of lithium bromide.

In general there are three types of air conditioning equipment being offered for conditioning blast furnace air. In the refrigerating system the moisture in the air is condensed by spraying chilled water or brine in direct contact with air or indirectly by means of air cooling coils. With this system the removal of moisture by condensation is before compression, that is, on the inlet or suction side of the blowing equipment. On account of freezing the lowest practical dew point is 41 F which is about three grains of water per cubic foot of air. By substituting brine for water or by adding a brine spray stage, sub-freezing can be obtained. Cooling to a temperature of 24 F gives one and one-half grains and to 16 F one grain per cubic foot of air. To go below 41 F with this type of equipment complicates the installation and increases its first cost and the cost of operation; therefore, it is not being advocated for less than three grains of moisture.

There is an after-compression system which also uses refrigeration. For this system moisture in the air is removed by condensation after compression, that is, on the pressure side of the blowing equipment. The air being under pressure, fairly low sub-freezing dew points can be obtained without resort to sub-freezing temperatures. This is best explained by stating that if the blast pressure is 15 psi gauge, two cubic feet of free air, including the vapor mixed with it, are compressed to a volume of one cubic foot. Cooling the compressed mixture to a temperature of 41 F equal to three grains of moisture per cubic foot will give a final moisture content corresponding to a free or re-expanded air dew point of 24 F equal to one and one-half grains of moisture per cubic foot and this low dew point may be obtained without the operating difficulties due to defrosting coils or of regenerating brine solutions.

The disadvantages of any system of moisture removal operating on the pressure side of the blower are:

The air entering the stoves is at a lower temperature, about 41 F, unless a reheating cycle is installed, and therefore requires more heat to bring it up to the desired hot blast temperature, which means more gas to the stoves.

The air pressure on the furnace may vary from zero to thirty pounds pressure and likewise in quantities from zero to 80,000 cfm.

Any air conditioning system must have a multiplicity of controls which, under the most favorable conditions is going to be a job to keep operating satisfactorily. Now to impose on the controls such a wide range of operating conditions as they will be required to meet on the pressure side of a blower is going to increase the difficulties from the controls and, in my opinion, become too complicated for the average blast furnace personnel. Several of these after-compression systems are being built for blast furnaces and it is going to be interesting to see how they work out under every day operating conditions.

In the dehydration system a liquid absorbent such as lithium chloride, Dow 8A or Dow 17A is used. These chemicals have an affinity for moisture. In these systems, which are located on the suction side of the blowing equipment, the incoming air is forced through contactor cells made of galvanized sheets or beds of Raschig rings which are small chinaware tubes flooded with the absorption liquid. On account of the available cooling water temperature these systems until the introduction of Dow 17A solution were limited to a three grain moisture per cubic foot of air during the summer months. There is one dehydration system in operation at the American Rolling Mill Company's Ashland plant. There are others under construction, including the one for our plant.

Time will not permit a detailed description of the various air conditioning systems proposed for blast furnaces. We have made a very intensive and thorough study over a period of months of this problem during which we had many interesting conferences and discussions with the sales engineers and representatives from the various manufacturers. All of these men gave generously of their time and efforts and put at our disposal such information which they had available. At the very beginning of our conferences we explained that what we were after was facts. Outside of the Woodward and Jones and Laughlin installations, there were no other practical data available. All was surmise, theory, and wishful thinking, based on such data and experience obtained on air conditioning installations other than blast furnaces.

I wish to state here that each of the various systems we investigated has it's merits and no doubt will find many places where it is the ideal system to be installed. For our particular purpose where we were going to explore the entire range of moisture contents we felt that a system which would give us the greatest flexibility with the minimum amount of equipment and still permit us to finally operate at the point which would be selected after these tests were conducted was best for our purpose. I again say that no one knows whether one, two, or three grains of moisture is the point at which we should operate. It has even been suggested by some operators that we may want to introduce moisture rather than extract moisture from the blast; in other words, there are advocates of four and one-half, five and six grains of moisture in the furnace blast. What the final answer will be I hope we will know within the next twelve months.

I believe there is as much confusion about the savings in steam and power with dry blast as there is in the determination of the proper moisture content. My investigations have led me to believe that any savings effected in the power for the blowing unit and the fuel in the furnace stoves offset each other due to the variations in the power required for the various units comprising the air conditioning system. We have checked into this carefully and know what the steam and power requirements are for each of the systems proposed, and I can say candidly that it was not a determining factor in making our selection, because the amount involved was insignificant when compared to the amount of gain made if air conditioning will increase the furnace production 10 per cent and reduce the coke consumption 8 per cent. In other words, if any such gain can be made in any blast furnace I am convinced that the first cost of the installation and the yearly cost of operation would be factors of minor importance in deciding on the installation.

R. VD. DUNNE: I am very appreciative of Mr. Clauss' remarks because I am one who spent a lot of time with Mr. Clauss on this problem of dry blast.

Mr. Clauss mentioned that he would like to know more about the Woodward installations, in regard to the advantages accruing and improvements made, during and before these advantages were indicated. I am reliably informed that Mr. Berg completed his improvements on furnace operation, including the treatment of his raw materials a year before dry blast was installed, and therefore from the recent figures obtained on November 1 on two furnaces, there was a 25 per cent increase on one furnace and 27 per cent increase in pig iron on another furnace, with respective savings in coke of 14 and 18 per cent, and this was made to the best of my knowledge one year after the other improvements were made.

One thing that has been of great interest to me is the marked improvement in iron production by the modern dry blast system over the Gayley plant. It has been suggested that other plant modernization would show equal or greater improvements than would dry blast. In the intervening years since the Gayley plants many of these improvements have been made. Mr. Gayley claimed that his plants would show an increase of 20 per cent in iron production. At this rate together with modern improvements in sintering, ore grading, etc., the law of diminishing returns for dry blast should certainly apply. The astonishing fact is that, in the light of present reports, increases in iron production have equaled or exceeded the Gayley claims. The comparison is interesting particularly as the plants obtaining these increases are operating at two grains higher moisture content than Mr. Gayley's.

L. L. LEWIS: While I was enjoying Mr. Clauss' remarks, I was also enjoying a recollection of the pleasure I had in working with Mr. Gayley quite a number of years ago.

One most interesting parallel was singled out — and I say this with as much of a smile as I can sincerely muster — in those days many proposals for dry blast were vetoed because the same amount of capital applied to other improvements appeared to offer a better return. It is most interesting to note that this perfectly legitimate difference of opinion should make its appearance again.

You have indicated a desire for me to tell you what increases in the output of your furnaces might be ob-

tained if they were equipped with dry blast. Frankly, I can't do this because I make no claim to operating experience. I can't comply for another reason and that is that I am convinced that the man who really knows air conditioning has spent too much time learning that practice to have gathered the knowledge and experience upon which to tell you fellows what you can get out of a furnace.

As to three grains, two grains, or one grain, I don't believe that any air conditioning man knows which is best — again because he is short on fundamental knowledge and operating experience. Hence, I can't tell you, much as I would like to, which one will enable you to make the most iron, or how much more you can get with one than the other.

I am convinced that the vital point is that air conditioning is an instrument or a tool with which the operator can eliminate certain considerable variable from furnace operation. It is a proven fact that he can eliminate these variables by bringing moisture down to three grains when it exceeds that outdoors and by bringing it up to three grains when there is a deficiency with respect to three. He can do exactly the same for two grains, or for one grain, or whatever point might be chosen. The result is regularity wherever the point is fixed.

What the operator will get out of his dry blast, in my opinion, depends upon two limits:

1. The maximum amount of iron which the furnace is capable of making under the many different physical limitations which apply, and
2. How much faith he has in the reliability of his dry blast equipment and with what willingness that faith will permit him to drive the furnace.

One or the other of these will be the top limit — one the top limit for one furnace, the other the top limit for another.

If you will base your consideration of air conditioning on these fundamentals and above all upon the concept that air conditioning is an instrument or tool with which a major variable can be eliminated, it will help all of us to get to the meat of the problem and to the point with more certainty and greater speed.

W. J. Rees: Mr. Dunne's paper was most interesting. His analysis of the power requirements for dry blast was very interesting, but this is but one of the many interesting phases of this subject.

I was glad to have had the privilege of investigating dry blast with Mr. Clauss. From his remarks you probably noted that when we got through with our investigation there still remained the suspicion that the savings claimed for it were not real.

Calculations are often made to show the large amount of water that is pumped into a blast furnace. In a large furnace, such as we recently blew in at Great Lakes, some 40 tons of water will be blown with the blast air in 24 hours and that seems like a great deal of water, but it should be remembered that some 4000 tons of air are pumped into the furnace in that same length of time.

Averaged over the year, probably not more than ½ per cent of the weight of air blown to the furnace is moisture. It is rather difficult to see how you can save 8 per cent in coke and have a production increase of 10 per cent in iron by eliminating that small amount of moisture.

However, theoretical calculations indicate that 20 lb of coke per ton of iron should be saved per grain of moisture removed, and if that saving can be realized we want it. If we effect that saving along with a 10 per cent increase in production, we will really be accomplishing something.

G. R. McDermott: I would like to know if the operation at Jones and Laughlin in the production of more uniform pig iron from the standpoint of chemical analysis has been evaluated in the open-hearth performance.

J. A. Clauss: I believe that one of the benefits accruing from air-conditioning on these installations that have been made is that they do get a more uniform iron, and we all know that if the silicon is kept at a fixed point so that it doesn't jump all over the map, the open hearth operation will be considerably improved.

As far back as 1927 air-conditioning has been used in foundry practice and it was claimed that air-conditioning improved the quality and gave a more uniform iron. It is because of some of these things that are not clearly defined that we do not know the complete story as to the advantages of air-conditioning, and we therefore have made arrangements to put in a unit to find out. We do not know, but we do think there is a lot in this.

When blowing 80,000 cfm of air having one grain of moisture per cubic foot, we pump into the furnace about eight and a quarter tons of water per 24 hr. For six grains of moisture per cubic foot, this is about 50 tons of water per day in the air blown into the furnace. Since air at 60 F and atmospheric pressure weighs about .075 lb per cu ft, we blow into the furnace in 24 hr 4320 tons of air. Now, since air contains about 77 per cent nitrogen and 23 per cent oxygen, this gives us 3326 tons of nitrogen and 994 tons of oxygen per 24 hr. For the sake of simplicity, let us forget for the moment that water by weight contains 1/9 hydrogen and 8/9 oxygen. Deducting the 50 tons of water from the 4320 tons of moisture laden air leaves 4270 tons of air. This amount of air contains 982 tons of oxygen, or 12 tons of oxygen per day due to the moisture in the air.

Since the oxygen in the air is the constituent which supports the combustion of fuels and other combustible materials, any variation in the oxygen content in the air blown into the furnace due to the moisture must be compensated by an increase or decrease in the amount of air blown into the furnace. Assuming that the furnace is in balance and everything is working fine, and that we are charging a given amount of coke and blowing a certain amount of air, it takes about eight hours for the coke (which is our carbon) charged at the top of the furnace to reach the zone of the tuyeres.

The atmospheric conditions can change in a comparatively short time and with it, the moisture content of the air. When this occurs, adjustments in the amount of air blown must be made to compensate for the variation in oxygen due to moisture because the furnace is full of coke (carbon) and it will be hours before a change in the amount of coke charged will bring the furnace in balance. From this it will readily be seen that with conditioned air if it does nothing else but keep the air at a predetermined moisture content, it will eliminate the necessity of changing the amount of air blown due to variations in atmospheric conditions. We thus eliminate a variable which, in my opinion, is a very important thing.

A. I. S. E. Annual Meeting and Engineering Conference

PITTSBURGH, PENNSYLVANIA

SEPTEMBER 22, 23, 24, 1942

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4. Carbon Brushes — Selection, Application, and Maintenance.
5. The Blast Furnace Skip Hoist.
6. Gauge Control in the Cold Mill.
7. Preparation and Handling for Welding.
8. A-C Welding in the Steel Industry.
9. Modern Welding Developments.
10. Application of Modern Cold Sawing Technique.
11. Development of Personnel in the Steel Industry.
12. Designing the Strip Mill for Moderate Capacity.
13. Electrolytic Tinplate.
14. Modern Roll Design Practice.
15. Roll Oils and Coolants for the Cold Mill.
16. Properties of Blast Furnace Cokes — Their Measurement, Significance and Control.
17. Survey of the Ore, Scrap and Pig Iron Situation.
18. Innovations in Coke Oven Design.
19. Benefication of Coking Coals and Its Effect upon Blast Furnace Performance
20. Turbine Lubrication.
21. The Use of Addition Agents in Petroleum Products.
22. Bearing Surfaces.
23. Round-table Discussion — Steel Plant Fuel Supply.
24. Relation of Flame Characteristics to Open Hearth Operation.
25. Fundamentals of Open Hearth Design.
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27. Determination of Blast Furnace Gas Credits.
28. Modern Turbine Types and Design.

PERFORMANCE of

By P. L. Betz

Consolidated Gas, Electric Light and Power Company of Baltimore, Maryland

Presented before
A. I. S. E. PHILADELPHIA DISTRICT SECTION

▲ THE process of cutting or burning steel with the oxy-acetylene or oxy-gas flame may be divided into two dinstinct operations. The first of these has for its object the preheating of the work to raise the temperature to the ignition point, and the second operation is the supplying of a stream of oxygen to initiate and maintain the cutting action. In the case of preheating, the temperature of the work close to the tip of the torch must be raised to approximately 1600 F, and this is done by the action of the preheat flames which are fed with a mixture of oxygen and fuel in such proportion as to give the maximum flame temperature. When the ignition temperature of the steel is attained, a blast of oxygen is directed to the steel close to the preheated region, and the steel burns freely in this oxygen atmosphere. Sufficient oxygen must be supplied to insure that oxidation can progress continuously through the thickness of the plate. As soon as the cutting begins, there is a liberation of a large amount of energy, since in the conversion of one pound of iron to iron oxide, 2900 Btu are evolved. This amount of energy, when liberated at the normal cutting rate, is greatly in excess of the energy supplied by the preheat flames to start the cutting process. For example, in the cutting of 1.25 in. steel plate at rates which yield high quality cuts, the heat energy evolved during cutting is from six to ten times as great as the preheat energy with either acetylene or gas as the fuel. During cutting, the preheat flames continue to function and supply energy to the surface of the work. However, additional energy is needed at the surface, as only a relatively small part of the heat evolved during cutting is available to the top surface of the work. Heat losses from this surface must be supplied by the preheat flames.

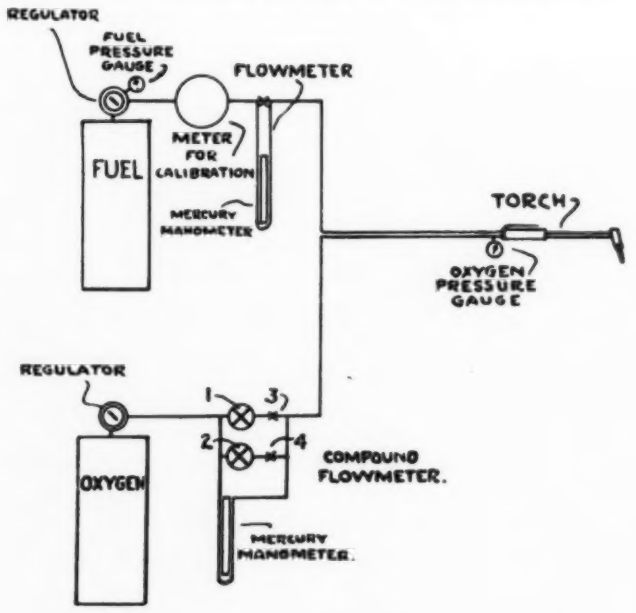
Aside from the thermal effects during preheating and cutting, there are many variables that influence the cutting performance. For a given preheat flame, the quality of the cut depends upon the speed of cutting, the thickness of the plate, the rate of flow of the cutting oxygen, the velocity of efflux of oxygen from the cutting orifice, the condition of the surface of the work. the composition of the plate to be cut, the presence of inclusions, etc., in the plate. Certain limits of cutting oxygen velocity and preheat volumes may not be exceeded for a given cutting tip, due to attendant turbulent conditions which may affect adversely the quality of the cut, producing irregularities in the surface of the cut.

Purpose of Present Investigation

Considerable development work has been done in the field of oxygen cutting where acetylene is the fuel used. Torches with well-designed tips are available that cover the range of metal thickness from .25 in. to 12 in. and over. Data are available on the performance of these tips at prescribed oxygen and acetylene pressures. Also, data are available giving recommended speeds of cutting for both hand and machine-operated torches. Thus it may be said that oxygen cutting using acetylene is in a high state of development.

During the last few years, articles have been published describing oxygen cutting where manufactured gas was the fuel used. In some instances, data are given on the performance of such fuel, but nowhere have the results been found of a critical analysis of the characteristics of gas as compared to acetylene for the cutting process. The need has been apparent for such analysis and the present paper is an attempt to do this. This work is divided into two parts, the first of which covers laboratory experiments to determine the characteristics with Baltimore city gas as the fuel as compared to the characteristics with acetylene as the fuel. This phase of the work leads to a basis for the design of cutting tips for city gas that give performance similar to that obtained when acetylene was used as the fuel. The second part of the work covers experiments at the Sparrows Point plant of the Bethlehem Steel Company in which cutting was done with coke oven-blast furnace gas as the fuel. The results obtained with this fuel are compared with those obtained with acetylene.

Figure 1 — Schematic diagram of experimental set-up.



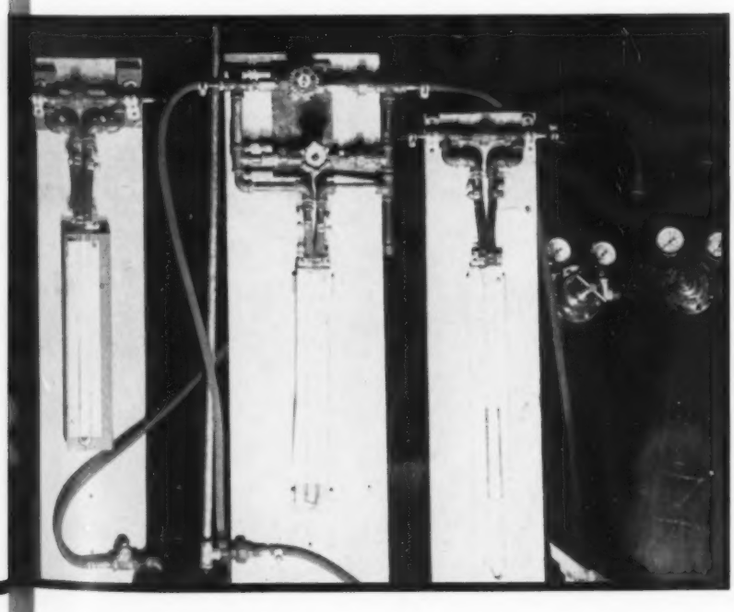
VARIOUS GASES *in the* OXYGEN *Cutting Process*

City Gas, Acetylene Experiments

In considering the quality of the cut, it would be convenient if some criterion could be established by means of which numbers could be assigned to a given cut quality. An attempt was made to do this based on measurements of lines which appear on the face of the cut and which are known as drag lines. Under conditions of cutting where high quality obtains, the drag lines diverge but slightly from lines perpendicular to the direction of the cut, and as the quality of the cut becomes poorer, these lines diverge more and more from this perpendicular relationship. Drag measurements were made of cuts obtained with city gas, and it was found that as the quality of the cut became poorer and poorer, due to increased speed of cutting, there was not a continuous and uniform change in the drag measurements. Similar experiments were performed using acetylene as the fuel in order to determine whether the irregularities observed with gas were peculiar to that fuel. Here, too, it was found that as the speed of cutting was increased, the drag measurements did not accurately indicate the condition of decreasing cut quality. In view of this it was concluded that drag measurements could not be made with sufficient accuracy to satisfactorily indicate the quality of the cut.

Attention was given to the quality of cuts obtained in a large number of experiments, and a criterion of quality was set up on the basis of these observations. To be satisfactory, the surfaces of the cut must be smooth, free of irregularities and the slag must be easily removable. This criterion was adhered to throughout the experiments described below, and, having once been established, there was little difficulty in distinguishing between good cuts and those not considered passable.

Figure 2 — View showing flowmeters indicated in Figure 1. Left to right: for acetylene, for oxygen and for city and coke oven-blast furnace gas.



Method of Test

Early in the work it became evident that fuel and oxygen volumes must be readily measurable and controllable. To this end, flowmeters were designed for use in the oxygen supply and also in the fuel supply. The flowmeters for preheat and cutting oxygen were calibrated by determining the weight and hence the rate of flow of oxygen for a given flowmeter reading. In the case of the flowmeters for acetylene and gas, the fuels were passed through a displacement meter from which the volume, and, therefore, the rate of flow was determined. Calibration curves were plotted showing the rate of gas flow under standard conditions (760 mm mercury pressure, 60 F) against flowmeter deflection.

Before discussing the actual laboratory experiments, let us first consider the method by which the results were obtained. Figure 1 indicates schematically the experimental set-up. It should be noted that in the oxygen supply system, a compound flowmeter is used. This consists of a U-tube mercury manometer of capillary glass tubing (in order to withstand oxygen pressures up to 50 psi) which indicates the pressure drop across either orifice 3 or orifice 4. Valve 1 is used in series with orifice 3, and valve 2 is used in series with orifice 4. Orifice 3 has a larger area than orifice 4 in order that it may be used to indicate the total flow of oxygen during cutting. Orifice 4 is used to indicate the flow of preheat oxygen.

When a preheat adjustment is to be made, valve 2 is opened and valve 1 is closed, thereby sending the preheat oxygen through orifice 4 and the mercury manometer indicates the flow of preheat oxygen. In order to cut, valve 1 is opened and valve 2 is closed, thus causing the total oxygen, that is, preheat plus cutting oxygen, to flow through orifice 3 and the rate of flow is indicated by the deflection of the mercury manometer. Separate calibrations are necessary for the

total oxygen and the preheat oxygen. A pressure gauge is shown in Figure 1 adjacent to the oxygen connection at the torch, and in the experimental work, the recorded oxygen pressures are those indicated by this gauge. This procedure of observing oxygen pressure at the torch differs from the usual cutting procedure in the field, but was found to be necessary in the experiments in order to eliminate the effect of the pressure drop that occurs in the hose between the oxygen supply and the torch. More will be said about this below.

Referring again to Figure 1, the fuel supply system needs little explanation. A flowmeter is shown in the fuel supply line. The fuel pressures recorded in the experiments are those observed close to the fuel flowmeter. A displacement meter is shown in this system which is used only when a calibration of the fuel flowmeter is required.

In proportioning the fuel to the oxygen for the preheat flames, the maximum flame temperature for the city gas occurs when the ratio of oxygen to fuel is 0.88, and in the case of acetylene, the theoretical ratio of oxygen to fuel is 2.5. In the literature on oxy-acetylene cutting, a ratio of 2.0 is generally used, and in experimental work to be described below a justification for this departure from the theoretical ratio of 2.5 will be found. To make a given preheat adjustment, valve 2 is opened, valve 1 is closed and the preheat control valves at the torch are adjusted together with the pressure regulators at the fuel and oxygen supplies. This having been accomplished, valve 1 is opened, and valve 2 is closed, in order to divert the preheat oxygen to the total oxygen orifice (3) of the flowmeter. Having made the proper preheat adjustment, the torch is now ready to initiate the cutting process. When the work has been properly preheated, the cutting valve at the torch may be opened to start the cutting action. The flow of cutting oxygen through the hose leading to the torch causes a considerable drop in oxygen pressure at the torch, and the procedure is to restore the desired pressure at the torch while cutting by manipulation of the oxygen pressure regulator. That portion of the cut made before the oxygen pressure is restored to normal is disregarded in the consideration given to the sample cut. Figure 2 is a photograph of the flowmeters indicated schematically in Figure 1.

Cutting Experiments Using Baltimore City Gas

Using the procedure outlined above and having first determined the volumes of acetylene and city gas suitable for the particular cutting tip employed and the thickness of the plate to be cut, a series of cuts was made to determine the effect of the following variables:

1. Speed of cutting.
2. Oxygen consumption over a range of oxygen pressures.

TABLE I

Thickness of steel plate = 1.25 in.

Experiment No.	Fuel, cutting tip	Oxygen pressure, psi	Hourly rate, cu ft			Rate of cutting	
			Fuel	Preheat oxygen	Total oxygen	Ft per hr	In. per min
240	Acetylene, Airco 3	40	10	20	141	77.5	15.5
236, 237		35	10	20	127	77.5	15.5
350		30	10	20	122	77.5	15.5
246	City gas, Harris 3 BTU	40	25	20	158	75	15
242		35	25	20	148	75	15
244		30	25	20	135	75	15
248		40	30	24	165	75	15
250		35	30	24	151	75	15
252		30	30	24	140	75	15
261	City gas, Harris 3 CT	35	25	22	168	85	17
264		30	25	22	152	85	17
262		35	30	26	170	85	17
266		30	30	26	156	85	17
268	City gas, Harris 3-53 BTU	40	25	20	144	84.5	16.9
270		35	25	20	133	84.5	16.9
272		30	25	20	123	84.5	16.9
274		40	30	24	145	84.5	16.9
276		55	30	24	138	84.5	16.9
278		30	30	24	128	84.5	16.9

Table I gives the results of the laboratory experiments where city gas and also acetylene were used as the fuel. In all cases, with the exception of experiment 350, cuts of good quality were obtained. In experiment 350 for acetylene using oxygen at a pressure of 30 psi, the quality was only fair. In comparing the performance of acetylene with city gas, experiments using the same oxygen pressure should be selected. Also, for city gas the data in Table I for the Harris 3-53 tip are better suited for such a comparison for reasons given below. Thus, experiment 240 may be compared with experiments 246, 248, 268 and 274; and experiments 236 and 237 may be compared with experiments 242, 250, 261, 262, 270 and 276. In each of these cases, similar cut quality was obtained with acetylene and city gas. It should be noted that high quality cuts were obtained with city gas using oxygen at 30 psi, (experiments 244, 252, 264, 266, 272 and 273) whereas with acetylene using oxygen at the same pressure, the quality of the cut was inferior (experiment 350).

The gas cutting experiments listed in Table I were made with Baltimore city gas having the following average composition:

CO_2	5.1%
Illuminants	4.8
O_2	0.9
CO	12.5
CH_4	23.9
H_2	32.7
N_2	20.1
Sp. Gr	0.614
Calorimeter Btu	500

This gas was compressed to approximately 1200 psi and stored in steel tanks. A standard pressure regulator was used to reduce the pressure to 12 psi for the cutting experiments. At the storage pressure some light oil condenses out of the gas with a resultant decrease in the Btu value for the gas. This, however, was not of sufficient magnitude to interfere with the cutting performance.

It will be noted that the heat of combustion of the city gas was 500 Btu per cu ft, while that of acetylene is approximately 1450 Btu per cu ft. Hence, in order to provide equal Btu input with city gas and acetylene, it takes three cu ft of city gas to equal the heating value of one cu ft of acetylene. Referring to Table I, it will be noted that the experiments on gas cutting were conducted with a Btu input equal to that of the acetylene experiments where thirty cu ft of gas were used per hr. A slightly lower Btu input was used in other city gas cutting experiments where 25 cu ft of gas were used per hr.

The data of Table I further indicate that with the Airco 3 tip (type 144) the total oxygen consumption is approximately the same as for the Harris 3-53 BTU tip. Therefore, the difference in cost of cutting with acetylene and city gas using these tips is closely the difference in cost between acetylene and city gas on an equal Btu basis.

The Harris 3 BTU tip employs preheat ports that accommodate approximately 25 per cent more preheat volume than the 3-CT tip. Also, the 3 BTU tip has a slightly smaller cutting port diameter than is used in the 3-CT tip. In Table I, data are given for a special tip obtained from the Harris Calorific Company which has the same preheat ports as the 3 BTU tip, but which has a cutting port corresponding to a No. 53 drill rather than the No. 52 drill used for the cutting port of the 3 BTU tip. This modified tip was made to our specification and is referred to as the Harris 3-53 BTU tip. The special tip was obtained in order that the total oxygen used during cutting would be more nearly equal to the total oxygen used in cutting with acetylene. This equality of total oxygen is desirable in view of the fact that

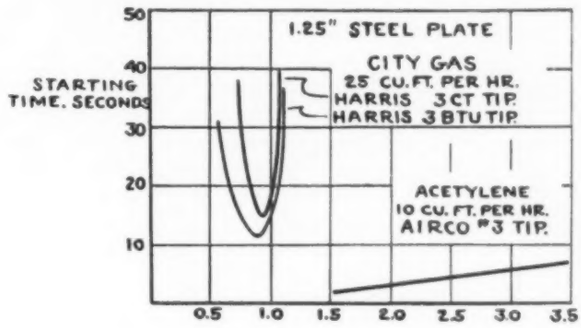


Figure 3 — Curves showing oxygen-fuel ratio.

equal velocities of efflux of the cutting oxygen will be obtained and the performance of acetylene and gas may be compared on a more equal basis.

Starting Experiments Using Baltimore City Gas

In the cutting experiments outlined in Table I, no attention was paid to the starting time for the cuts. The reason for this was that there was no uniformity or standardization of the edge at which the start was made. In order to obtain a starting edge that was more nearly reproducible in its characteristics, it was found desirable to prepare the edge by making a cut at low speed, and under conditions that produced a cut of high quality. This edge was then cleaned of slag and scale and the upper surface was wiped lightly with emery cloth to remove loosely adhering particles. With such an edge, a high degree of reproducibility in starting time was obtained. Figure 3 gives the results of starting tests for city gas and acetylene where various values of oxygen to fuel ratio were employed. Here the starting experiments with city gas were made with a slightly lower Btu input than in the starting experiments with acetylene. This was done to bring out more clearly the different starting characteristics of the two fuels. It will be noted that the characteristic curve for city gas differs considerably from that for acetylene. In the case of city gas, a V-shaped curve was obtained having a minimum starting time in the vicinity of theoretical oxygen to fuel ratio (0.88) while for the case of acetylene, a straight line starting characteristic was obtained. For acetylene, the starting time decreased as the oxygen to fuel ratio was decreased through the range of from 3.5 to 1.5. For lower values of ratio than 1.5, the starting time with

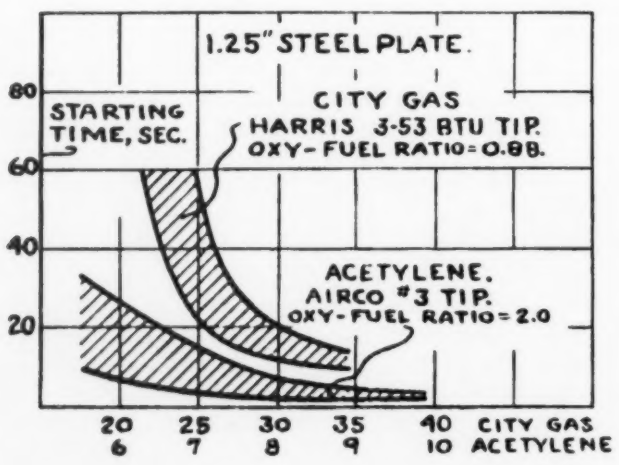
acetylene was found to be erratic and to increase rapidly so that starting with ratios lower than 1.5 would not be feasible. Mention was made above that the theoretical oxygen-to-fuel ratio for acetylene is 2.5 and that the literature on the subject generally indicates the use of a ratio of about 2.0. It may be seen from the acetylene characteristic of Figure 3 that this reduction in ratio is justifiable and desirable, inasmuch as the quantity of preheat oxygen and the starting time are both reduced thereby. In the case of the city gas characteristic curves given in Figure 3, two types of cutting tips were employed. In both cases, however, the same quantity of fuel, 25 cu ft per hr, was used in the preheat adjustment. The preheat characteristic of the 3 BTU tip is similar to that of the 3-53 BTU tip, since the preheat ports are similar in these two tips.

The effect on starting time of using various fuel volumes in the preheat adjustment is indicated in Figure 4. In these experiments, a prepared edge was used for starting, and referring to Figure 4, it will be seen that the lowest starting times were obtained at the higher fuel rates. At the rate of 35 cu ft of city gas per hr, the starting times were low and closely grouped, and as the fuel rate was decreased, the starting times increased and became more erratic. At 20 cu ft per hr, starts were not obtained within 120 sec. In Figure 4, the oxygen-to-city gas ratio was approximately 0.88, and the tip employed was the Harris 3-53 BTU tip. The performance of the 3 BTU tip would be similar to that of the 3-53 BTU tip, since these tips have the same preheat port area and arrangement.

Figure 4 includes the starting performance for acetylene cutting using various rates of fuel consumption. The Airco 3 tip was used, and the oxygen to fuel ratio was adjusted to approximately 2.0. Here it is seen that the spread in starting times increases as the fuel rate is decreased.

Figure 4 indicates that somewhat longer starting periods are required with city gas than with acetylene. An effective way to reduce the starting time with city gas is to produce a slight irregularity at the edge where

Figure 4 — Curves showing fuel rate, cu ft per hr.



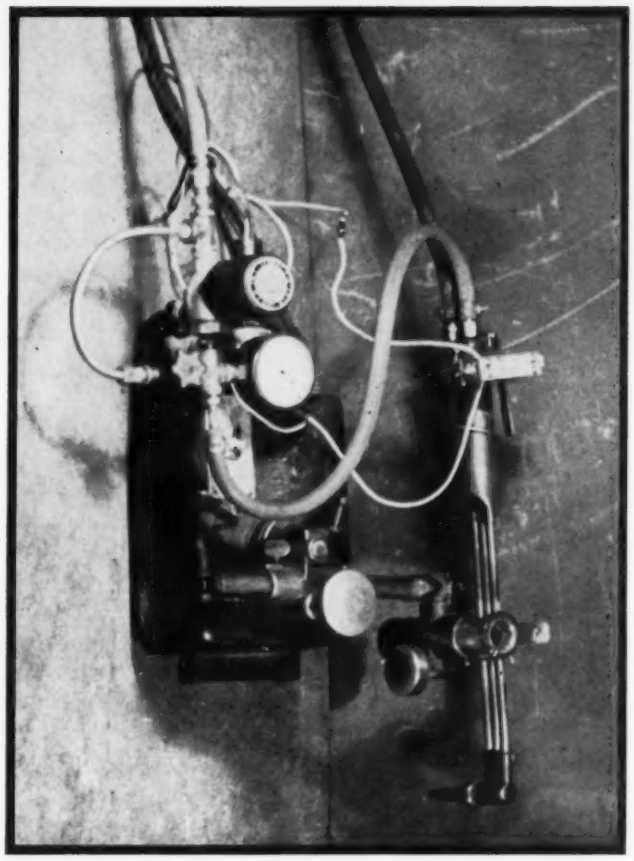


Figure 5 — Device used to maintain constant oxygen pressure at the torch.

the cut is to be initiated. This may be done with a cold chisel or by nicking the surface with a hack-saw. In one case, the starting time at a smooth edge was found to be 22 sec, and when an irregularity was produced at this edge with a hack-saw, starting was accomplished in 7 sec. In another case, the starting times varied between 11 and 17 sec with no edge treatment, and with an irregularity at the edge, starts in 4 and 5 sec were obtained.

Experimental Procedure vs. Field Cutting Procedure

It has been indicated above that the procedure in carrying out the experiments was to maintain the correct oxygen cutting pressure at the torch, despite the drop in pressure that occurs when the cutting oxygen is turned on. This procedure differs from that used under field cutting conditions where compensation is not generally made for the pressure drop in the tubing, due to the flow of cutting oxygen. In the case of cutting with city gas with the Harris 3-53 BTU tip and with acetylene with the Airco 3 tip, it was found that when the oxygen pressure was set at 50 lb at the torch, the flow of cutting oxygen caused the pressure to fall to approximately 41 lb at the torch. This reduced oxygen pressure at the torch reduces the amount of oxygen supplied to the preheat mixture during cutting. The amount of this reduction was determined for both city

gas and acetylene, and in the case of city gas, where the preheat ratio was originally 0.8, at an oxygen pressure of 50 psi, the decrease of oxygen pressure due to the flow of cutting oxygen caused the preheat ratio to fall to 0.56. When acetylene was used as the fuel with an original preheat ratio of 2.0, the flow of cutting oxygen caused the preheat ratio to fall to 1.55. Interpreting Figure 3 as indicating the rate at which energy is supplied to the work for various preheat ratios, it is seen that in the case of city gas a change of ratio from 0.8 to 0.56 shifts the starting time from approximately its minimum value to a considerably longer period, and would indicate that during cutting at the lower preheat ratio, the preheat energy is being used less efficiently. In the case of acetylene, a change of ratio from 2.0 to 1.55 gives rise to a shorter starting period at the lower ratio, and this would indicate that during cutting with acetylene at the lower ratio, the preheat energy is used more efficiently.

The need is therefore apparent for means to eliminate the adverse effect of lowered oxygen pressure during cutting with city gas. One solution is the provision of means for automatically maintaining the oxygen pressure at the torch constant during preheating and cutting. Another solution is the use of a three-hose torch which provides a separate hose for the preheat oxygen and a separate hose for the cutting oxygen. Regarding means for automatically maintaining the oxygen pressure constant at the torch during preheating as well as during cutting, a device may be used which consists of a throttle valve which is by-passed with a supply line controlled by a valve. This by-pass valve should be arranged to open and close with similar operation of the cutting valve of the torch. The device should be installed close to the torch and should be operated so that after the preheat adjustment is made at the torch at the desired oxygen pressure, the cutting oxygen is turned on and the oxygen pressure at the regulator is increased to compensate for the pressure drop in the hose. When the desired oxygen pressure is again obtained at the torch, the cutting oxygen is turned off. This causes the by-pass valve to close and the preheat oxygen again flows through the throttle valve. The throttle valve is then adjusted to restore the oxygen pressure at the torch to the pressure at which the preheat adjustment was made. Thereafter, the proper oxygen pressure is maintained at the torch during preheating as well as during cutting.

Tip Design for Gas Cutting

The question now comes up as to how to apply the results of these experiments to the cutting of metal of different thickness from that used in the experiments. First, it must be assumed that the state of the cutting art is, briefly, that tips for acetylene are available for the cutting of all usual thicknesses of metal and that satisfactory results may be expected. Further, tips for cutting with city gas are available, but usually will not be found to have the desired characteristics. This is probably due to the fact that these tips are intended for use on a number of different gases and when used on a particular gas may not have the most desirable characteristics. On this basis, then, the procedure is to determine the characteristics of the acetylene tip that will give suitable cutting performance and from these characteristics, to determine the characteristics desired in the city gas cutting tip for the same work. In determining the characteristics of the tip for use with acetylene, the rate of acetylene consumption for cutting the thickness of plate under consideration is of first importance. The quantity of preheat oxygen for this acetylene tip may be determined on the basis of a preheat oxygen-to-fuel ratio of 2.0. The total oxygen used for acetylene cutting must also be determined, and from these data, the following characteristics for acetylene may be determined:

1. Rate of consumption of acetylene.
2. Rate of consumption of preheat oxygen (equals 2.0 times the acetylene rate).
3. Rate of consumption of cutting oxygen (the difference between total oxygen and the preheat oxygen rate).

Based on the present experiments, these three factors for the acetylene tip may be used to determine corresponding factors for the gas tip.

The gas tip should accommodate such a volume of gas that the preheat flames are provided with approximately the same number of Btu as in the case of the acetylene tip. Where the gas has a heat of combustion of 500 Btu per cu ft, this volume is equal to three times the acetylene volume. The preheat oxygen rate for the gas tip may be determined by multiplying the preheat gas rate by the preheat oxygen to fuel ratio, 0.88 in the case of city gas. The cutting oxygen orifice of the gas tip is to be such as to pass the same quantity of cutting oxygen as the acetylene tip under similar oxygen pressure conditions.

A satisfactory gas tip, such as one of the Harris BTU type, having the above characteristics, may be expected to yield performance as far as cutting speed, quality of cut and total oxygen consumption, similar to that obtained with acetylene. This city gas tip will not have the same starting characteristics as the acetylene tip; the starting time in general will be somewhat longer for city gas. Actual starting times with city gas under field conditions are given subsequently in this paper. However, it has been shown that a marked decrease in start-

Figure 6 — Photograph showing sample cuts on 1.5 in. plate, using coke oven-blast furnace gas.

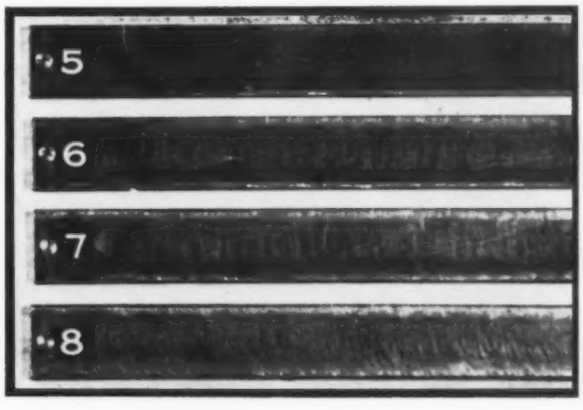


TABLE II

Thickness of steel plate = 1.5 in.

Experiment No.	Fuel, cutting tip	Oxygen pressure, psi	Hourly rate, cu ft			Rate of cutting		Starting time, sec
			Fuel	Preheat oxygen	Total oxygen	In. per min	Ft per hr	
SP 24, 25		50	10	20	170	15.5	77.5	3, 4
SP 26, 27	Acetylene,	40	10	20	152	15.5	77.5	4, 3
SP 28, 29	Airco 3	30	10	16	124	15.5	77.5	4, 4
SP 17, 18, 19	Coke oven gas	50	30	27	176	15.5	77.5	7, 5
SP 20, 21	Harris	40	30	27	154	15.5	77.5	7, 5
SP 22, 23	3-53 BTU	30	30	27	129	15.5	77.5	4, 5

ing time with city gas is possible by nicking or otherwise producing an irregularity at the edge at which the cut is to be initiated.

Coke Oven-Blast Furnace Gas and Acetylene Cutting Experiments

Upon completion of the experimental work in the laboratory, the apparatus was taken to the plant of the Bethlehem Steel Company at Sparrows Point, Maryland. Here, 500 Btu coke oven-blast furnace gas at a pressure of 10 psi was available and was used in starting and cutting experiments. The cutting experiments with coke oven-blast furnace gas were paralleled by cutting experiments using acetylene.

An average composition of the coke oven-blast furnace gas is as follows:

CO_2	2.92
O_2	0.62
Illuminants	2.83
CO	8.13
CH_4	26.75
H_2	47.13
N_2	11.64
H_2S	0 grains per 100 cu ft
Sp. Gr.	0.459
Calorimeter Btu	501.9

In the experiments using coke oven-blast furnace gas, means were employed to provide constant oxygen pressure at the torch during preheating and also during cutting. This was done with the throttle valve bypass valve arrangement referred to above and shown in Figure 5.

Cutting Experiments Using Coke Oven-Blast Furnace Gas

Data are given in Table II for the cutting performance of coke oven-blast furnace gas and also for acetylene in the cutting of 1.5 in. steel plate. For the gas cutting, the Harris 3-53 BTU tip was used, and for the acetylene cutting the Airco 3 (type 144) tip was used. Referring to Table II, it will be noted that for each oxygen pressure, the oxygen consumption was closely the same for gas as for acetylene cutting.

Cutting speeds are given in Table II under the heading "Rate of cutting," and these correspond to speeds at which cuts of good quality were obtained. These speeds are slightly in excess of those at which what might be called "perfect" cuts were obtained. Thus, the quality of the cuts in experiments SP 24, 25 was similar to that in experiments SP 17, 18, 19; that in SP 26, 27 was similar to SP 20, 21; and that in SP 28, 29 was similar to experiments SP 22, 23.

Starting Experiments Using Coke Oven-Blast Furnace Gas

Referring again to Table II, it is seen that the starting of the cut with coke oven-blast furnace gas is somewhat slower than when acetylene is used. Thus, the average starting time with gas was 5.5 sec as compared to an average starting time of 3.7 sec for acetylene.

Summary

A. The proper ratio of preheat oxygen to fuel in the case of city gas and coke oven-blast furnace gas is approximately 0.9, and in the case of acetylene, is approximately 2.0.

B. Justification is found for the use of an oxygen-to-fuel ratio of 2.0 in acetylene cutting rather than the theoretical ratio of 2.5.

C. Cutting experiments on steel plates 1.25 and 1.5 in. thick indicate that when city gas or coke oven-blast furnace gas is used as the fuel, cutting results are obtained that are similar to those obtained with acetylene, where equal oxygen pressure and cutting oxygen volumes are used.

D. The volume of gas to be used in the preheat should be such as to provide approximately the same number of Btu as when acetylene is used.

E. The starting time with gas as the fuel is somewhat longer than when acetylene is used. In the experiments using coke oven-blast furnace gas, the average

starting time was of the order of 6 sec and in similar experiments using acetylene, the average starting time was of the order of 4 sec.

F. Starting time can be reduced by nicking the edge of the work where the start is to be initiated.

G. The reduction in oxygen pressure at the torch due to the flow of cutting oxygen causes a reduction in the preheat oxygen to fuel ratio. This results in a slightly decreased starting time where the fuel is acetylene and an increased starting time where gas is the fuel. Two methods are proposed for eliminating this difficulty. One consists in the use of a device to maintain uniform oxygen pressure at the torch during preheating and cutting. This method was used in the experiments at the Bethlehem Steel Company. The other method for eliminating the difficulty is the use of a 3-hose torch having a separate preheat oxygen supply hose.

H. Total oxygen consumption in cutting with city gas or coke oven-blast furnace gas equal to that used for acetylene cutting may necessitate the use of a special gas cutting tip.

I. A procedure has been outlined by which the required characteristics of a gas cutting tip may be determined from the characteristics of acetylene cutting tips known to be suitable for the work under consideration.

The author acknowledges the cooperation of the Bethlehem Steel Company in providing certain facilities for making the experiments outlined above. The constructive criticisms of Mr. A. J. Fisher of that company were especially helpful.

Appendix

In order to give a better idea of the quality of the cuts made in the experiments, reference is directed to Figure 6. In making the cuts of Figure 6 the only variable was the speed of cutting. In each case the preheat conditions were 25.3 cu ft of gas per hr and 22.8 cu ft of oxygen per hr. The total oxygen during cutting was 149 cu ft per hr. Cutting speeds were as follows: sample 5, 11.0 in. per min; sample 6, 12.4 in. per min; sample 7, 13.5 in. per min; and, sample 8, 15.5 in. per min.

In these samples cuts at speeds up to and including 13.5 in. per min (No. 5, 6, 7) were of the highest quality — square upper and lower edges and flat cut surface. In the cut at 15.5 in. per min (No. 8) the upper and lower edges were square, but there was a concavity in the face of the cut of the order of approximately one-sixteenth (.0625) in. Aside from the slight concavity, this cut was of high quality.

DISCUSSION

PRESENTED BY

N. C. BYE, Chief Engineer, Henry Disston and Sons, Philadelphia, Pennsylvania

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

F. C. SCHOEN, Assistant Master Mechanic, The Midvale Company, Philadelphia, Pennsylvania

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

M. J. CONWAY, Special Engineer, Lukens Steel Company, Lukens Steel Company, Coatesville, Pennsylvania

P. L. BETZ, Research Department, Consolidated Gas Electric Light and Power Company, Baltimore, Maryland

N. C. BYE: I want to express thanks to Dr. Betz for giving us a great deal of information on something upon which there have been practically no data available up to the present time. The question of torch cutting by using city gas and acetylene as different types of fuels has had all sorts of advantages claimed for each of them but actual operating results have not been presented. One thing that I am very much impressed with is the accurate data you have given us on actual operating conditions.

It is my understanding that one of the advantages claimed is that if air hardened steel is to be cut, city gas is better than acetylene because the temperature produced on the cut edge would be lower and therefore would be less injurious to the steel. As I gather from your paper, the gas itself produces only the preheating effect necessary to ignite the steel and that the resultant temperature on the face of the cut product would not be materially different as long as both gases were used to equal efficiency.

Also, from the curve which you have shown us on the heating effect with different proportions of city gas and oxygen, there is a distinct dip and rise on that curve. I noted that you showed that when the oxygen pressure dropped at the torch, due to the increased load of the cutting oxygen with long hose lines, the fuel-oxygen ratio decreased from .88 to .56 with resultant loss of efficiency. If, by poor adjustment, the operator set the fuel-oxygen ratio to 1.2, would there also be a loss in efficiency as the ratio increased beyond the .88 point?

I would like to know if there is any way in which the operator in the field has any means of knowing where he stands in regard to establishing an .88 gas-oxygen ratio or a 2.0 acetylene-oxygen ratio either by means of the gauges on the torches or by working back to the data given on the tips themselves.

I would also like to know if the principle of the fuel oxygen curves applies to the use of propane or butane and if there are any data available on those.

L. F. COFFIN: Dr. Betz has given us in a most clear manner, the reason for many of the difficulties that have been experienced in the use of coke oven gas for cutting and some that may continue to be experienced in the future. I feel confident with the fundamental knowledge that Dr. Betz now has, that these problems can be solved. I would like to call attention to some of the pitfalls that Dr. Betz might experience and should strive to overcome.

It appears that possibly the most readily obtainable and quick answer to the use of coke oven gas would be

in the clean cutting that prevails in the fabricating shops and for use in radiographs and other machine cutting tools.

In steel plant repair work, salvage work and miscellaneous scrap burning where the surfaces are not only rusty but heavily scaled, and where they are covered with paint, a cutting problem exists, but I have no doubt that Dr. Betz will solve it. In the past, coke oven gas or city gas was given somewhat of a bad reputation possibly because it had been tried out in those days more with hand burning, and burning the kinds of materials to which I refer.

F. C. SCHOEN: I have operated a hand cutting torch a few times, using the propane gases at 12 to 15 lb pressures on the regulator. I am wondering if you used somewhat similar pressures for the city gases?

Another question is: How much work has been done by use of city gas for torches in the scarfing processes, that is, for conditioning surface defects in steel?

A. J. FISHER: I think Dr. Betz has started the ball rolling on the use of coke oven gas for the burning of steels. There are a lot of practical problems to be considered in this work of Dr. Betz. In using coke-oven gas in times past, most of us have gone out and hooked onto the mill gas system, and have used conventional hose and torches, etc. Accordingly, we had irregular results. Coke oven gas, as a rule, has a lot of sulphur in it — about 400 grains per cubic foot. This sulphur in going through the conventional tips and valves corrodes them badly, and they fail to function in a very short time.

The first thing to do would be to condition the gas; compress it to the proper pressure, and manifold it in large lines to the point of consumption. After conditioning the gas and getting it to the torch, then we must call on Dr. Betz, to develop special tips and procedures for each thickness of plate to be burned.

I have witnessed the burning of coke oven gas in two of our plants and have noted exact and delicate work being done. Although the starting time is a little slow, due to lower flame temperatures, the quality of the cutting is very good.

M. J. CONWAY: Dr. Betz has approached the problem of using various types of fuel with oxygen for flame cutting from a very practical angle. We who have had many grevious as well as pleasant experiences in the use of hydrocarbon gases as opposed to acetylene, have long known that at least equal speed and quality of cut are obtainable at no additional oxygen cost and with the fuel saving outlined by Dr. Betz in his paper. But in the past, we obtained our comparable results with good management and cutting technique rather than from the practical fact-finding procedure given in this paper. Some reason for this is due to the fact that when approached strictly as a theoretical combustion problem, the operation is successful but the patient dies. By the application of some of the well-known combustion engineering principles such as the maintenance of pressures at varying rates of flow, removal of obstructing orifices which have no regulating purpose, etc., improvement of the gas cutting operation and gas consumption are attained.

Through a series of tests in which propane and oxygen and acetylene and oxygen were used and eight million square inches of plate were cut during the test, we found that through management alone and existing equipment, at least a 10 per cent improvement could be made. We also found that, as substantiated by the data in Dr. Betz's tables, if proper attention is paid to time consumed in starting, the cutting rate and oxygen consumption are comparable with both hydrocarbon gases and acetylene gases and, therefore, the difference between the Btu cost of the two operations is a definite saving.

P. L. BETZ: Mr. Bye asked about the cutting of air-hardening steels; whether slightly better cutting performance was obtained with gas than with acetylene. I have never worked with the air-hardening steels, but from the work that I have done, it appears that breaking down the cutting problem to one of preheating and one of cutting leads to the conclusion that cutting with city gas is no different from that with acetylene, as long as equal Btu inputs and equal volumes of oxygen are used with tips having suitable characteristics.

As to the "V" curve of oxygen-to-fuel ratio vs. starting time (Figure 3 of the paper) if the preheat mixture is adjusted to give a ratio of the order of 1.2, the preheating would be done less efficiently than with the theoretical ratio, and would result in a longer starting time. During cutting, the increased flow of oxygen would cause the oxygen pressure at the torch to decrease and a lower oxygen-to-fuel ratio would obtain in the preheat flames. The actual point on the "V" curve at which the preheat flames operate during cutting depends, of course, on the amount by which the preheat oxygen flow is decreased during cutting.

As to cutting characteristics with propane, I have not as yet made tests with this fuel. However, I expect to use propane in the near future.

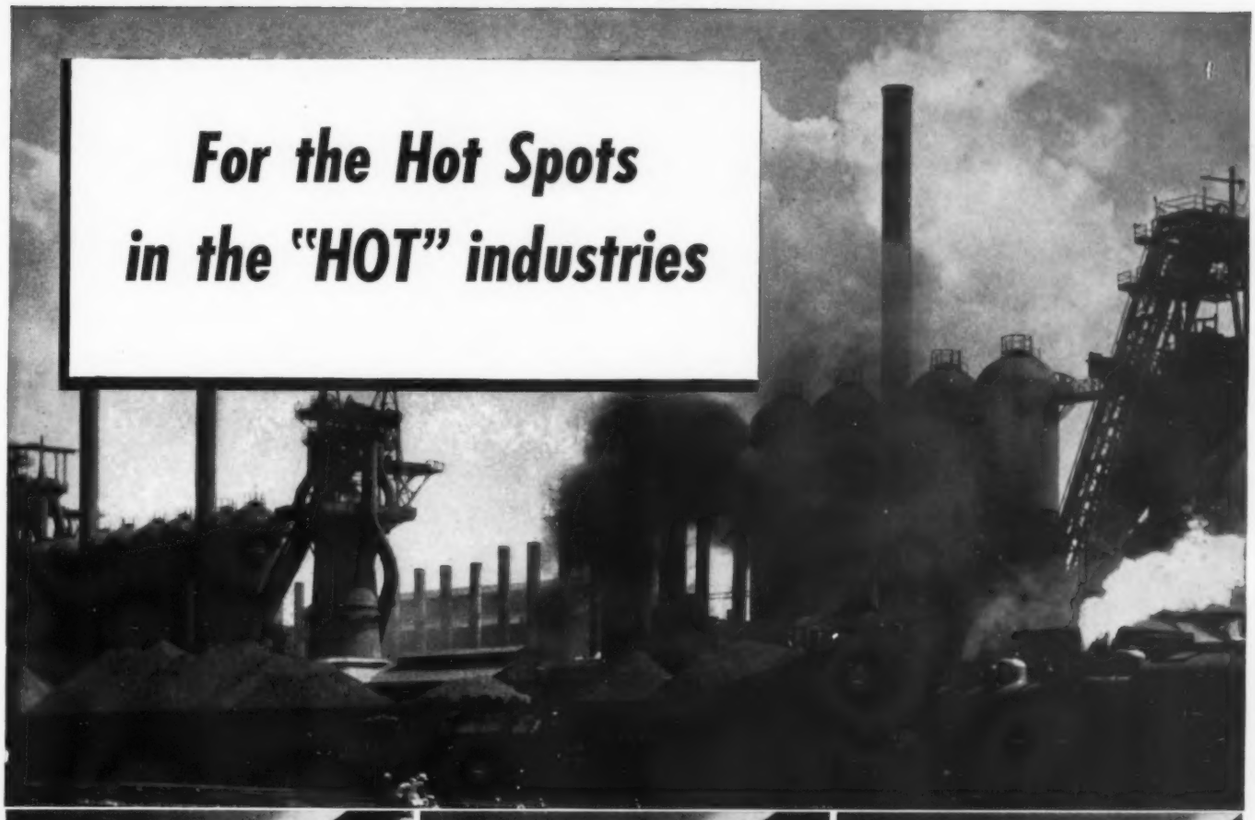
Mr. Schoen asked about the gas pressures used. In the Sparrows Point experiments, with coke oven-blast furnace gas, the pressure was 10 psi. In the city gas experiments in Baltimore, the gas was compressed into tanks to about 1200 psi and a pressure regulator was used to reduce the pressure to 12 psi.

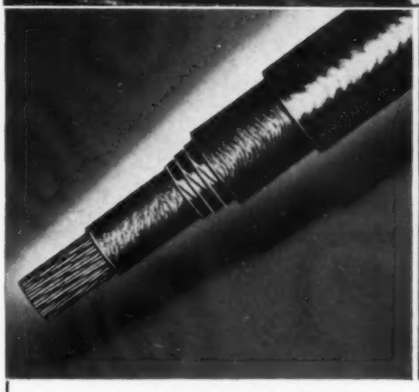
As to scarfing, I do not know how much of this type of work has been done with city gas. I have not made tests along this line.

Mr. Coffin referred to some of the pitfalls, some of them being painted and scaled plates. In the laboratory experiments some of our plates were given two or three coats of red lead paint before being cut, and we found that the painted plates could be cut as readily with city gas as with acetylene.

In the case of scaly plates, we had one that was rather badly scaled, and the cutting was interfered with considerably with both acetylene and city gas. In such cases, it is especially important with both fuels to increase the quantity of preheat fuel with a corresponding increase in preheat oxygen.

As to the difference in cost, this, of course, depends on the relative cost of acetylene and gas. The same amount of cutting oxygen would be used with either fuel with the tips that have been considered here so that cost is balanced with either fuel. The tests indicate that the net saving with city gas or coke oven-blast furnace gas over acetylene is the difference in cost of these fuels on an equal Btu basis.





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BROWN DISCUSSION

(*Continued from page 37*)

W. G. CRANE: I have just one thought. Mr. Brown stated that bonderized sheets couldn't be soldered. How are the can companies going to get around that?

C. E. BROWN: It is probable that the bonderized material will be used largely for can ends. As far as soldering is concerned, that doesn't actually mean that the sheet couldn't be fabricated into a can product but that the metallic bond that is ordinarily established in soldering at the side seam may not — I won't say, will be, as we know soldering today, completed over the bonderized surface.

Now, it is possible that you might strip the film of bonderized protective coating at that particular point and either weld the side seam or solder it or cause adhesion by some other method. What I meant was that directly the soldered bond wouldn't be affected over the bonderized film.

W. G. CRANE: At present they intend to use it mostly for the ends?

C. E. BROWN: I believe so.

LESLIE BERNICK: I would like to ask Mr. Brown one question. What are the factors determining the adhesion of lacquers to tin plate and to black plate, say, especially concerning surface and oxides?

C. E. BROWN: In the first place, the surface should be clean; that is, it should be relatively clean of foreign matter. I believe you are speaking only of lacquer or enamel adhesion to the base metal. Well, your surface should be clean and free from foreign material, and primarily it should be what we call a white finish or, if you will, a deoxidized sheet, although in some cases you do have discoloration from annealing borders that cannot be eliminated entirely, or it creeps in once in a while on a small percentage of the product, and that may or may not under certain conditions have some effect. But I think that your condition of surface of the sheet depends upon whether it is extremely bright or whether you have a satin or velvet finish, or whatever you might want to term the sheet finish.

Then, too, something goes on from that point with the lacquer and enamel producer, and also your method of application, and the baking temperature, and the weight of the film. If from the results of any considerable number of investigations the details are ever published — after all, the results in any one field are of necessity limited — you may be able to obtain certain light coatings. About the only thing you can claim now are the results that you get from a relatively small number of experiments, so that you cannot claim a general result that would be applicable in any field.

However, in the case of some of these coatings, you find them more adhesive than others. Some appear to work better with a size coating. And in the case of some, the thickness of film and baking temperature are critical considerations. All of those factors — and each one separately — affect the condition of the finished surface and the protection that you get.

As an example of a small variable that might have a considerable effect, some lithographers claim that they can get better corrosion protection by placing their sheet, as it passes to the oven, from a horizontal position — at an angle, let us say, of about 45 degrees — for some ten feet or so, until it goes up into the wickets in the oven. While a great many ovens of that type are built, there are a great many ovens built in which it just passes out in a horizontal position and stands up immediately as it passes through and is supported by the wickets. So while one fellow may claim that he has a superior type of baking equipment, there is perhaps 50 per cent or more of the other type, and they seem to get along pretty well. So those are variables, each one of which may have an effect.

A. H. BRISSE: I was interested in your mention of certain possible substitutes for tin; namely, the use of silver as a protective coating. Could you tell us something more about that, Mr. Brown, if you will?

C. E. BROWN: Generally, I should say that it is practically impossible to try to cover every substitute in detail that is offered, and while a great many of these substitutes appear to have merit, it would take a crew about as large as is needed to run the OPM to chase all these things down. But I am informed that the cost of protecting one square foot .001 thickness with silver is, I think, something in excess of 28 cents for the metal alone. While it may not be necessary to go to such a heavy film, when we recognize the extremely thin film that you put on tin plate and the much lower cost, you can see that the cost item there is such that you wouldn't be able to sell sanitary cans for anywhere near the same price at which they are sold today.

COOPER DISCUSSION

(*Continued from page 54*)

appears to be a very excellent point. A second method of correcting this difficulty is local annealing of the weld. Annealing is not necessarily an inexpensive operation but it is very effective, particularly on strip containing carbon contents above the extremely low ranges.

Unsatisfactory weld quality may be the result of many factors, such as improper edge preparation, improper current, improper welding sequence, improper current interruption, poor machine maintenance, etc. The use of electronic timers for controlling the current interruption on flash welders is becoming more popular. Excellent results have been obtained with this type of equipment in the spot welding of light gauge steels and nonferrous metals such as brass and aluminum. Considerable experience is also being obtained on the advantages of electronic control in connection with flash welding equipment used in cold strip processing.

J. H. COOPER: There is one more comment I should like to add concerning this annealing. This comment is that you might gather from the discussion that to be sure, absolutely sure of low breakage record, annealing is necessary. To go on that assumption would be a mistake. Annealing is not necessary for low carbon steel of the order of .06 per cent carbon. If, however, you are welding a material with air hardenable properties, by all means anneal. If you are discussing steel to be used for tinplate, the majority of the breakage is caused by mechanical troubles. If the welder dies are in alignment, and the weld is trimmed properly, there is no necessity to anneal low carbon steel. When you weld higher carbon material, it is another picture entirely.

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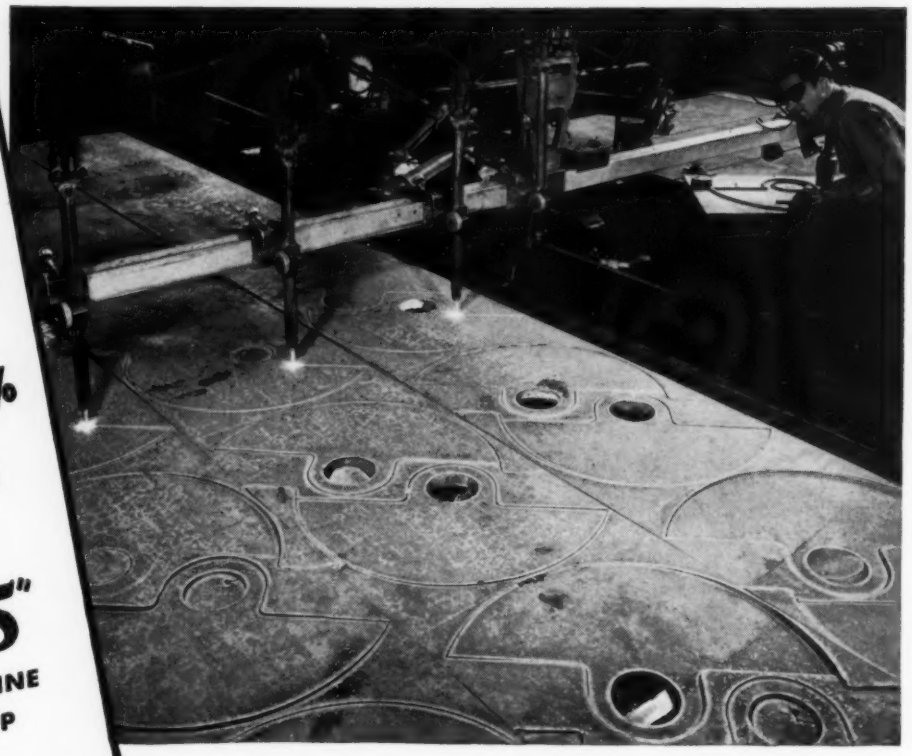
HIGH-SPEED MACHINE GAS CUTTING TIP



Improved performance with Airco "45" tips over standard machine gas cutting tips

Metal Thickness	Average % increase in cutting speed	Average % savings in oxygen consumption
½"	21.1	14.2
1"	22.2	24.0
2"	25.8	39.5
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Figures shown are averages obtained in survey recently completed in Philadelphia area.

Additional proof of the outstanding performance of the new Airco "45" High-Speed Machine Gas Cutting Tip was obtained in a survey of representative plants in the Philadelphia area. On steel thicknesses of ½" to 3" a direct comparison with previous results was obtained. The results of this survey are tabulated here. Note that in addition to increasing metal cutting speeds, Airco "45" Tips make possible considerable savings in oxygen . . . a most important consideration in our country's united war effort.

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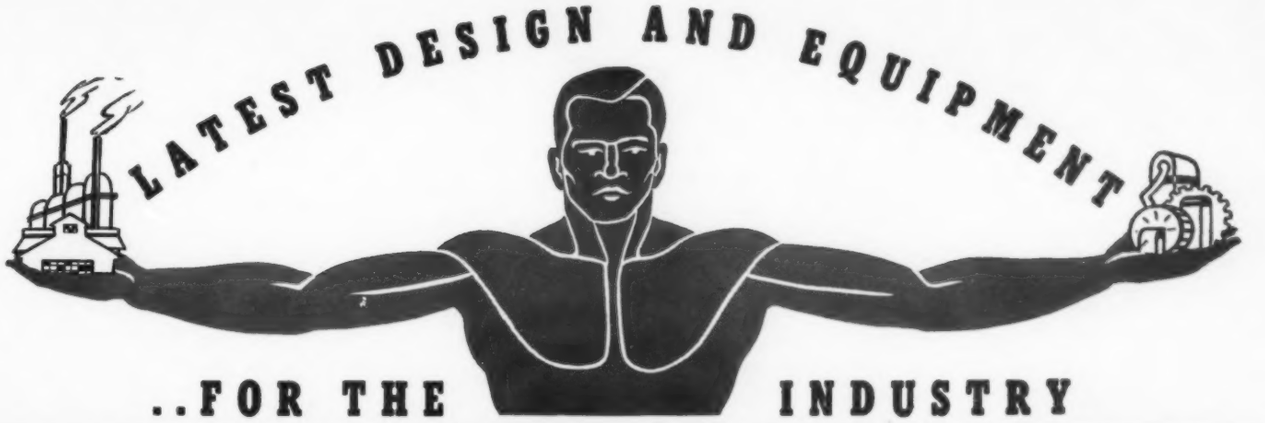


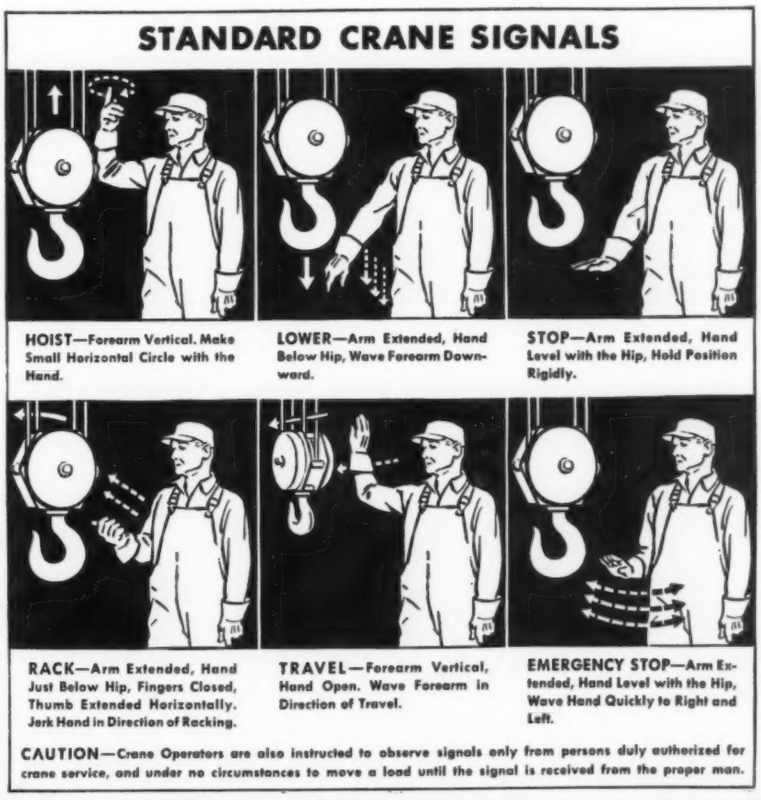
STANDARD CRANE SIGNALS PROPOSED

▲ Operating an overhead traveling crane efficiently and safely calls for teamwork. The man at the controls and the floormen must use the same "language." The "language" is a clear signal system. Without such signals, a moving crane hook, with or without a load, can be as great a menace to safety as it is an aid to handling materials. This is more true now than ever before, with so many plants crowded and busy with hustling war work, and with a constantly increasing number of inexperienced men entering into factory jobs. Today, when the nation needs productive man power so badly, is certainly not the time to neglect workers' safety.

Now — in order to step up crane efficiency and as an extra precaution against accidents — is a good time to make sure that your crane men know the standard operating signals illustrated herewith, and are using them. These signals are universally used. They are simple — easy to remember — and can be learned with only a few minutes practice.

As a further precaution against trouble, it would not be out of order for plant foremen on floors using overhead cranes to put floormen through signal drills at periodic intervals. This will assure adherence to the standard signal system. Plants using crane crews are less likely to experience trouble on this score, but, it is advisable to instruct the operators to observe signals from crewmen on floor only, and under no circumstances to move a load until signal is given by the proper man.

The Harnischfeger Corporation, Milwaukee, Wisconsin, manufacturers of P & H overhead traveling cranes, will, on request, gladly supply cards illustrating the standard crane operating signals. They are suitable for wall hanging. Address your request to the Crane Division.


STANDARD CRANE SIGNALS
HOIST—Forearm Vertical. Make Small Horizontal Circle with the Hand.
LOWER—Arm Extended, Hand Below Hip, Wave Forearm Downward.
STOP—Arm Extended, Hand Level with the Hip, Hold Position Rigidly.
RACK—Arm Extended, Hand Just Below Hip, Fingers Closed, Thumb Extended Horizontally. Jerk Hand in Direction of Racking.
TRAVEL—Forearm Vertical, Hand Open. Wave Forearm in Direction of Travel.
EMERGENCY STOP—Arm Extended, Hand Level with the Hip, Wave Hand Quickly to Right and Left.
CAUTION—Crane Operators are also instructed to observe signals only from persons duly authorized for crane service, and under no circumstances to move a load until the signal is received from the proper man.

NEW SYSTEM FOR CLEANING PIPE

▲ In almost every manufacturing step in the production of seamless steel tubular pipe, heavy heat treat scale is formed. This has always been a vexing problem because of high cleaning costs and the difficulty of removing the scale uniformly.

Very little had been done to improve this condition until the National Supply Company, Spang-Chalfant Division, Ambridge, Pennsylvania, took the "bull by the horns" and decided to do something about it.

For many years the pipe made by this prominent company was cleaned by an outside jobbing concern. Inasmuch as this arrangement did not afford the proper control and close supervision desired, the company determined to incorporate the cleaning operation with their other manufacturing processes.

The problem consisted of cleaning both the interior and the exterior of all "Spang" low carbon and high alloy seamless steel pipe, which varies

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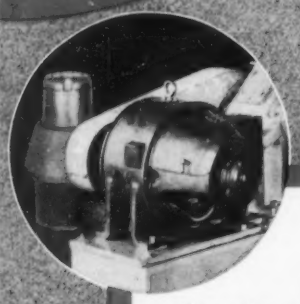

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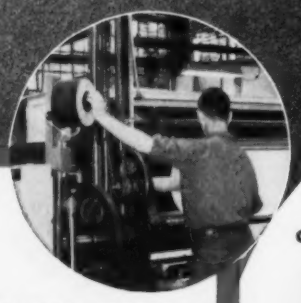

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Obtained electrically either by operation of speed adjuster handle or *stop* button.

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Torque is provided to suit the job. No clutches are needed. Acceleration is smooth so that driven machine and material in process are not subjected to undue shock or strain.

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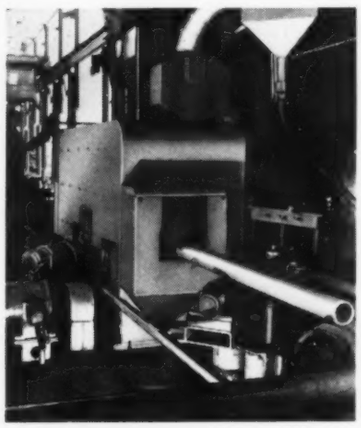
from 2 in. to 14 in. OD and from 18 ft to 50 ft in length.

A cleaning system built by American Foundry Equipment Company, 555 S. Byrkit Street, Mishawaka, Indiana, was specially designed to handle this application. The equipment includes an airless Wheelabrator for cleaning the exterior of the pipe and an air blast for descaling the interior.

It is difficult to give standard production figures as to cleaning speed because this depends entirely upon the size of pipe, the type of steel from which the pipe is made, and the condition of the scale due to previous heat treatments.

A cleaning production for 4½ in. standard low carbon pipe, however, is being obtained at the rate of 18 ft per min for the exterior and 14 ft per min for the interior.

A special cabinet housing two stand-



ard Wheelabrator blast units is used for cleaning the outside of the pipe. The Wheelabrators, mounted in the bottom of the cabinet, blast upward and in direct line with the rotating pipe as it passes through the cabinet on the conveyor mechanism. Since the distance between the Wheelabrator and the surface to be blasted is constant for all sizes of pipe, uniform cleaning is assured.

Travel of the pipe on the conveyor rolls through the cabinet is continuous — loading being handled at one end of the cabinet and unloading at the other. As the complete length of pipe enters the cabinet, another pipe is rolled into position for entry into the blasting area. After external cleaning the pipe is automatically rolled off the conveyor onto skids preparatory to the internal cleaning step.

Due to the different types and sizes of pipe and the diverse scale encrustations encountered, each of which may require a slightly changed cleaning speed, the conveyor rolls can be varied as to the number of revolutions per minute and as to the skew angle. In this way it is possible to control the length of time the pipe is held in the blasting area.

In the accompanying illustration the cleaned pipe is shown being discharged. The operator is controlling the flow of metallic abrasive to the two Wheelabrator units.

The air blast machine, specially designed for cleaning the interior of the pipe, is located adjacent to the Wheelabrator cabinet.

As the externally cleaned pipe leaves the Wheelabrator cabinet it is rolled on skids to the air blast machine where cleaning of the interior is accomplished with a lance type blast nozzle long enough to blast the entire interior surface of the long pipe.

This nozzle is inserted into the end of the rotating pipe, which is supported on revolving steel discs. Both the speed at which the pipe rotates and the feed of the nozzle can be regulated to obtain the most effective cleaning.

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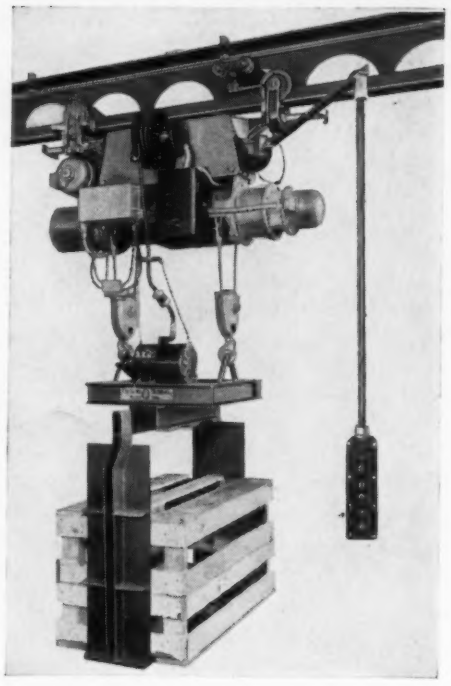
The air blast tank, which controls the mixing of air and abrasive (steel grit) to the desired proportions, and the storage hoppers, are mounted on a steel car riding on a track. As the nozzle travels into the pipe, cleaning as it progresses, the whole blast mechanism rides forward, being drawn by a steel cable.

A belt conveyor, mounted under the pipe cleaning device, returns the spent abrasive from the far end of the pipe to the boot section of the elevator for recirculating in the blasting equipment.

After the interior of the pipe is cleaned the nozzle is retracted, the pipe kicked off the discs to nearby skids, and a new length of pipe rolled into cleaning position.

HANDLING DEVICE FOR CRATES OR BOXES

▲ One of the newest developments of the Cleveland Tramrail Division of the Cleveland Crane and Engineering Company, Wickliffe, Ohio, is the motor-driven crate grab and carrier



This motor-driven crate grab permits quick stacking of crates or boxes to great height.

especially designed for handling crates and boxes in and out of storage, or from one elevation to another. The unit enables the quick stacking or removal of crates at a great height with safety. This makes possible faster handling, and also greater storage capacity of a given area.

The grab and carrier are completely motorized with all operations conveniently controlled by the six buttons of the push-button station. If desired this type unit can be provided with an operator's cab in which all controls may be located.

The arms of the grab are extended and retracted by means of geared slide bars that are driven by the motor mounted on top of the grab. Power is supplied to this motor through a flexible cable that is held taut by a spring-type retrieving reel.

A double-hook cable type electric hoist elevates and lowers the grab with very little swing, making it easy to spot it as desired. A quick acting electric brake stops and holds the load wherever desired.

The unit illustrated will handle one or more boxes at a time. It will lift loads up to 1500 lb a distance of 20 ft. The arms may be spread to a maximum of 36 in. and retracted to a minimum of 18 in. Similar units can be built for heavier loads and to suit other dimensions.

(*Please turn to page 85*)

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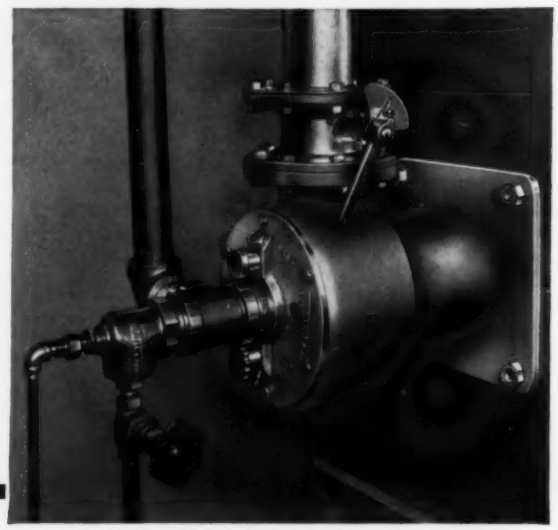

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This is a war of machines and armaments, and vast quantities of power are required to build them. Despite all the other forms of energy, 60% of all horse-power required by American industry comes from coal.

Our whole civilization is based on coal, and our whole *defense* of that civilization is based on it. Coal provides heat. Gasoline can be made from coal. Rubber is about to be made from it. Many vitamins are coming from coal's derivatives.

Coke made from coal is indispensable to steel. Railroads consume one out of every five tons mined. Dozens of vital industries look to it for one or more of the 150,000 chemical compounds already identified through coal carbonization.

Koppers builds most of the coke ovens which carbonize millions of tons of coal . . . is an important producer of chemicals for war . . . of anti-aircraft gun mounts, airplane catapults . . . airplane, submarine, diesel and automobile piston rings . . . Fast's Couplings for power transmission . . . pressure-creosoted timber, ties and piling . . . and dozens of other products. Koppers Company, Pittsburgh, Pa.

Buy United States
War Bonds and Stamps

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

Workers in our Bartlett Hayward Division are now privileged to wear the Navy "E" emblem

for

DISTINGUISHED SERVICE

Our workers in the Bartlett Hayward Division at Baltimore are now privileged to wear this emblem, a mark of unusual honor and distinction.

It symbolizes the most respected and coveted award conferred by the United States Navy on civilians: the "E" for excellence in industrial production.

This award was recommended by the *Bureau of Aeronautics.* Only two other American industrial concerns have been so honored. It was given because of ingenuity in applying straight-line, mass-output methods to the production of catapults for launching airplanes from the decks of naval vessels, and because of substantially bettering scheduled deliveries.

We are proud of these employees whose unceasing efforts have been so dramatically recognized, just as we are proud of those who are now serving in the armed forces. This war is being fought in the factory as well as on the battle-front. Both jobs must be *well done.*

All over the country, thousands of fellow-employees in the Koppers organization are likewise engaged in helping to arm America. They are building by-product coke plants and processing plants, producing coal and its innumerable derivatives, coke, chemicals, treated timber products, piston rings, special metals, fabricated parts and other materials and implements needed in titanic quantities by The United Nations. To each of them, this Navy "E" will bring added inspiration and a new appreciation of the vital importance of his share of the job.

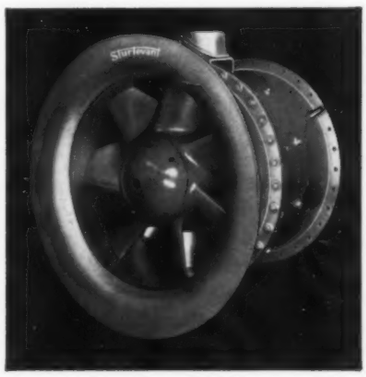
KOPPERS COMPANY PITTSBURGH, PA.

KOPPERS...THE INDUSTRY THAT SERVES ALL INDUSTRY

FAN DESIGN OFFERS MANY FEATURES

▲ A radical innovation in axial-flow fan design has recently been announced by B. F. Sturtevant Company, Hyde Park, Boston, Massachusetts. This new fan, which bears the name "Victory Axiflo Fan" possesses outstanding features in performance, quiet operation and savings in weight, space and power which have never before been approached in fans of the axial flow type.

For the duration of the war the use of the Victory Axiflo Fan must be restricted to the U. S. Navy, where it is now being used for heating, ventilating and mechanical draft service on battleships, cruisers, destroyers, and airplane carriers. At the conclusion of the emergency, it will be available to industry. Because of the great advantages which the new fan possesses for practically every type of ventilating, air-conditioning, mechanical draft and industrial application, the manufacturers anticipate that demands will be extreme when the need for rigid operating economies returns with the revival of competition at the conclusion of the war. Already the makers are preparing to meet these demands.



This new axial-flow fan effects marked savings in weight, space and power.

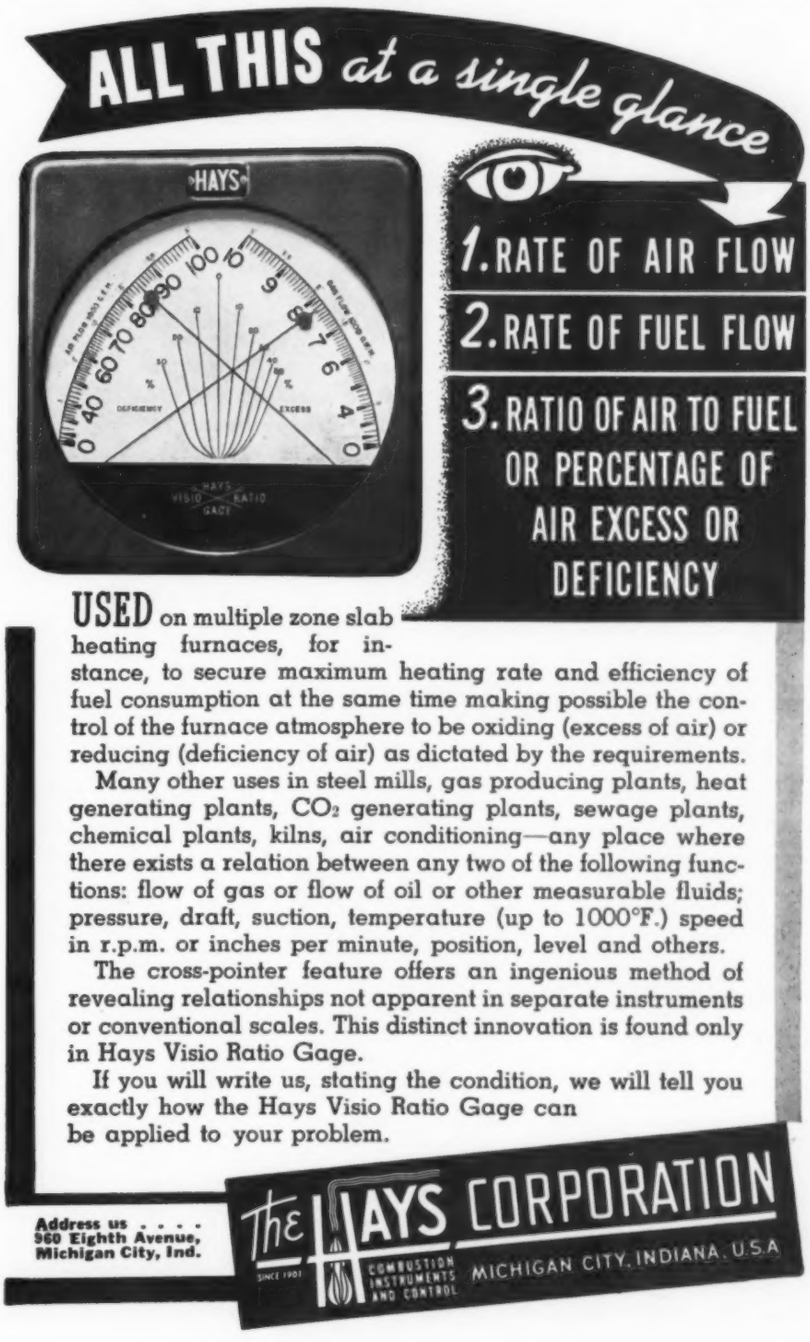
Among the outstanding features of this new fan are: (1) Mechanical efficiency over 90 per cent. (2) Extremely quiet operation (example: a given unit produces only 80 decibels when supplying 12,000 cfm at 3 in. s.p.). (3) Comparatively small size, light weight, compact (weighs only about 60 per cent as much as other fans for comparable service). (4) Pressures range from ½ in. to 6 in. wg. for the motor-driven ventilating fan (illustrated above); other designs with turbine drive operate against pressures as high as 60 in. H_2O. (5) High rotative speeds (motor-driven units adapted to 1160 and 1750 standard speed motors; turbine-driven units operate at speeds as high as 5000 rpm). (6) Extremely wide ranges of sizes and volumes.

Bulletin No. 460, illustrating various designs and construction details will be sent by B. F. Sturtevant Company on request.

WOODEN PICKLING TANKS

▲ Among interesting substitutes being used by war-time industry is an acidproof brick-lined wooden pickling tank, in the development of which Sauereisen Cements Company, Sharpsburg, Pennsylvania, played an important role. Its war service consists in overcoming difficulties in obtaining steel tanks or rubber-lined tanks due to current shortages.

Work on early pickling tanks of this type, which could utilize the


ALL THIS at a single glance
HAYS
1. RATE OF AIR FLOW
2. RATE OF FUEL FLOW
3. RATIO OF AIR TO FUEL OR PERCENTAGE OF AIR EXCESS OR DEFICIENCY
USED on multiple zone slab heating furnaces, for instance, to secure maximum heating rate and efficiency of fuel consumption at the same time making possible the control of the furnace atmosphere to be oxiding (excess of air) or reducing (deficiency of air) as dictated by the requirements.
Many other uses in steel mills, gas producing plants, heat generating plants, CO_2 generating plants, sewage plants, chemical plants, kilns, air conditioning—any place where there exists a relation between any two of the following functions: flow of gas or flow of oil or other measurable fluids; pressure, draft, suction, temperature (up to 1000°F.) speed in r.p.m. or inches per minute, position, level and others.
The cross-pointer feature offers an ingenious method of revealing relationships not apparent in separate instruments or conventional scales. This distinct innovation is found only in Hays Visio Ratio Gage.
If you will write us, stating the condition, we will tell you exactly how the Hays Visio Ratio Gage can be applied to your problem.
Address us . . . . 960 Eighth Avenue, Michigan City, Ind.
The HAYS CORPORATION
SINCE 1901
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

company's experimental advances in technical cements, was undertaken before America foresaw the present emergency. Mr. C. Fred Sauereisen, president, was a leader in introducing silicate of soda, quick setting cements for this purpose. These cements had advantages of high temperature resistance, long wearing qualities, and did not require special waterproofing treatment.

The first tank built according to the company's specifications was in Pittsburgh in 1936. Its structure may be described as follows: An existing wooden tank was first lined with a cold acid-proof plastic about three-quarters of an inch thick for expansion and double-sealing. This plastic lining and the exterior wood were both lined with protective hard-burned brick laid in modern silicate acid-proof cements.

The ruggedness of this tank under use and complete effectiveness in preventing escape of acids endowed it with many of the attributes of the steel tank. More were built; and they have proved especially practical in resisting both muriatic acid solutions used in galvanizing departments and in resisting sulphuric acid solutions.

Today, Mr. Sauereisen reports, they are in use in a number of steel works, where they have freed steel and rubber for direct use in armaments. They represent, he said, another of many contributions of the technical cements industry to help it meet war-time conditions.

CROUSE-HINDS CONDULETS
for uninterrupted service

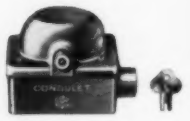
Now, when the demands of the defense program call for greater and still greater production, shutdowns caused by either equipment failure or sabotage can be disastrous. This is no time to take chances. In remodeling or expansion plans, specify Crouse-Hinds **CONDULETS**. Then you can be sure that these sturdy conduit fittings and enclosures will give your electrical system maximum protection against tampering and accidental electrical failures.

CONDULETS—The standard of quality in the field of conduit fittings.

Type EPC Explosion-Proof Combination Line Starter Conduilet — Air Break
Handle Padlocked

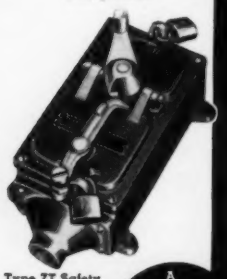
Type GUSC Explosion-Proof Line Starter Conduilet
Padlocked in "off" position

Type WMK Weather Resistant Safety Switch Conduilet
Cover and handle may be padlocked together



Type FS Vaportight Switch Conduilet, Key Operated

Type OFC Explosion-Proof Push Button Station Conduilets
With padlock



Type ZT Safety Switch Conduilet
Double padlock protection

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CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

ANNOUNCES TRUCKS FOR BATTERY OPERATION

▲ With operating schedules stretching to a 24-hr, seven-day basis and with the available supply of manpower steadily shrinking, one manufacturer of power trucks has gone "all out" in its effort to co-operate with the government and with industry in the equipment of mills and factories in the metal working field, and transport organizations, to move swiftly and safely the rapidly mounting volume of war materials and machines.

Clark Tructractor Division of Clark Equipment Company, Battle Creek, Michigan, has for more than twenty years built gas-powered vehicles for handling materials, parts and finished products in factories, at railway terminals and on marine docks. While continuing to supply these gas-powered fork trucks, platform trucks and tractors as before, it is now making its trucks of still greater importance in the war production program by providing them with full electric equipment for storage battery power, where electric operation seems best fitted to the job.

The machines lift from 2000 to 7000 lb, using an hydraulic vane type pump driven by special series wound motor. The same pump operates the tilting unit, which enables the operator to tilt the load back 10 degrees in 5 seconds, for safe riding and tilt it forward 3 degrees in 1 second for tiering. The machines have four speeds forward and four speeds in reverse, with speeds up to 6 mph under full load, 7.5 mph empty. The trucks will climb 7½ per cent grades under their maximum loads. Drive is on the front wheels, with rear wheel steer. Drive axle is of Clark special double reduction gear and pinion type mounted on ball and roller bearings. General Elec-

tric drive motor is mounted directly to the axle and drives through ring gear and pinion.

Standard equipment includes hydraulic brakes, centrally located control levers, spring mounted, rubber cushioned seats, disc type wheels, electric horn. The motors and electric control equipment are supplied by General Electric. Customer has his choice of Edison alkaline battery or any standard make of acid battery.

ARMCO CONTINUES TO BREAK RECORDS

▲ Breaking war-time production records has become a habit for the Ashland, Kentucky, division of the American Rolling Mill Company.

Russell R. Smith, manager, announced that the division had made the 1000th (one thousandth) production and maintenance record since Pearl Harbor, consisting of 624 operating production records and 376 maintenance records.

He also reported it is indicated the division will shortly more than double the total number of production records made during the entire year 1941.

In addition, Smith announced that during June a new monthly high was set for shipments of steel, largely plates and sheets, topping the previous monthly shipping record set in May, 1941, by 1886 tons.

At the same time, he reported, rotary shear group No. 2 sheared 578,570 lb of steel in a single eight-hour shift.

Another record, Smith stated, was set for unloading freight cars laden with iron ore, when 3965 tons of ore were dumped on the stockpile from sixty-one cars at the rate of 82½ tons per minute.

For the fourth consecutive month, the Hamilton plant of the same company has set a new high monthly record for production of pig iron.

June production topped the May figure by 314 tons.

When March production set a peak, Ora Clark, director of the War Production Drive at the plant and Fred Baker, assistant to the director, wired Donald M. Nelson, chairman of the War Production Board that the record wouldn't last long. It didn't, and each month to date the plant has overcome numerous obstacles to push output above levels said by blast furnace builders to be "maximum."

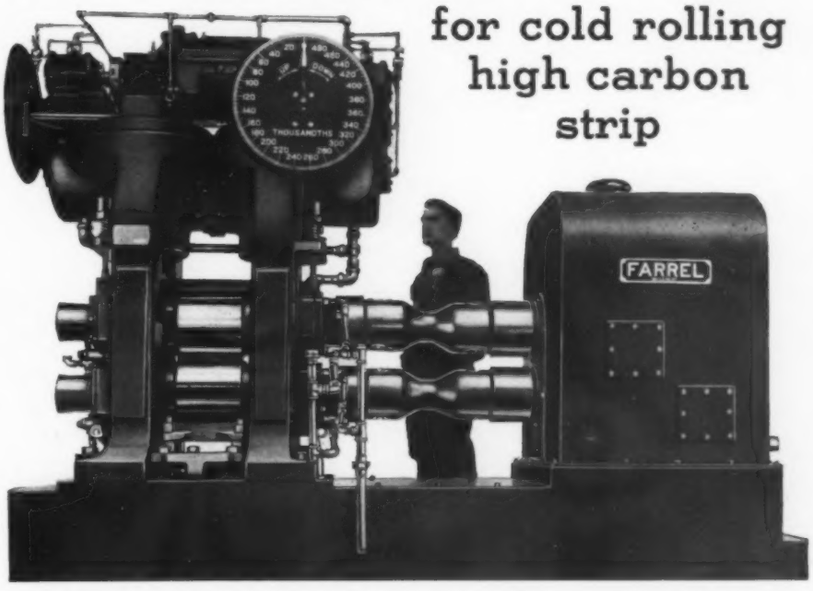
It was decided to paint a large "V" on a gas container at the plant with a chevron beneath it for the March record. As new records were set more chevrons were added. The gas container now looks like the sleeve of a top sergeant; Donald Nelson has received another telegram and the blast furnace "experts" are re-checking their slide rules.

Establishing five new weekly production records, the Chicago district plants of Carnegie-Illinois Steel Corporation, United States Steel subsidiary, during the last week of June rolled a tonnage of steel plates sufficient to provide armor plate for more than 7000 light medium tanks.

Among the weekly production records established recently was one for blast furnace output by the Chicago district plants which topped previous records by approximately 1100 tons. At Gary Works, the blast furnaces established a new record with a total production of 83,837 net tons.

Three plate production records were also broken recently. The total plate production for Chicago

NEW HIGH-SPEED
HIGH-PRECISION FARREL MILL
for cold rolling high carbon strip



Ruggedly built for continuous, high-speed operation, this new Farrel 10″ x 10″ Two-High Rolling Mill is also specially designed to insure high accuracy and close control of gauge in cold rolling high carbon steel strip.

A feature is the built-in screwdown, which is extremely high-powered to adjust the gauge on high carbon steel under full load. This screwdown provides ease of manipulation and facilitates setting the rolls with extreme accuracy. Duplex control is provided for operating either screw independently or synchronizing both screws through magnetic clutches.

The rolls are forged alloy steel, heat treated and hardened. They are carried in precision-type, flood-lubricated sleeve bearings and are connected to the pinion stand with universal spindles. The mill housings are of cast steel of heavy section for maximum strength and rigidity.

The mill is driven by a variable speed, reversing motor through a combined reduction gear unit and pinion stand, with Farrel-Sykes continuous tooth herringbone gears and mill pinions mounted in anti-friction bearings in a welded steel housing.

Farrel Rolling Mills are designed and built to fit individual conditions of operation, and experienced engineers are available for consultation to assist in working out applications to special production requirements.

FARREL FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.
New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

district plants was increased by almost 7000 tons over the best previous record which was established the week ending June 20. The 80 in. hot strip mill at the Gary Sheet and Tin Mills, which formerly produced lighter gauge steel and was recently converted to plate production, reached a new high, as did the 160 in. continuous plate mill at Gary Works.

PRODUCES PIPE FOR OIL LINE

▲ Production of large diameter steel pipe for the new 550-mile petroleum line extending from Longview, Texas, to a point near Salem, Illinois, has begun under a government directive at National Tube Company's Lorain, Ohio plant at the specified delivery rate of almost five miles a day, it was announced by B. F. Harris, president of the United States Steel Corporation subsidiary.

Destined for the world's largest oil-carrying line, the pipe is 24 in. in diameter and three-eighths of an inch thick. The National Tube Company has the only seamless pipe mill capable of turning out this large size pipe.

National Tube workmen are turning out approximately 1200 tons of the pipe daily, or enough to fill 40 railroad cars. At this rate of production, the 137,500-ton order is expected to be completed within approximately four months.

The pipeline, when completed, will deliver an estimated 300,000 barrels of oil daily for transhipment to the eastern seaboard, where a steady flow of oil is vital to the war effort.

In announcing that production has begun on this important government order, Mr. Harris emphasized that other vital war production in National Tube plants, such as bombs and shells, will continue uninterrupted at an even greater rate of production, and in addition the company will supply the bomb tubing requirements of a large proportion of the firms which are entering the field of bomb production. A number of these firms will employ the "spinning method" developed by the National Tube Company which is being turned over and assistance rendered to them by the company without charge.

HEATING FURNACE CONTRACTS AWARDED

▲ The Rust Furnace Company, Pittsburgh, Pennsylvania, announces it has been awarded the following contracts, at a total cost in excess of $1,000,000:

For Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania, two large slab heating furnaces for the new plate mill at Homestead, Pennsylvania. Contract was awarded by Mesta Machine Company, Pittsburgh, Pennsylvania.

Also for Carnegie-Illinois Steel, five car bottom furnaces at another Pennsylvania location.

For Columbia Steel Company, Chicago, Illinois, three large slab heating furnaces, to be installed in Utah. For Caine Steel Company, Chicago, Illinois, three forging furnaces, to be installed in Tennessee.

ADDITION OF OTIS STEEL BOOSTS J & L CAPACITY

▲ The Jones & Laughlin Steel Corporation, Pittsburgh, increased its annual steel ingot producing capacity approximately one million tons when it took over the Otis Steel Company, Cleveland, in a 39 million dollar transaction.

H. E. Lewis, president of Jones & Laughlin said, "Foremost consideration will be given at both properties to getting out the greatest possible production of steel for war. The workmen at Jones & Laughlin and Otis have made many outstanding production records of which they have the right to be proud."

The sale was ratified by Otis shareholders on April 24th in line with a contract between the companies entered into in February. An operating, marketing and distributing center at Cleveland was listed among other advantages J & L gains by the transaction. E. J. Kulas, former president of Otis, becomes a director of Jones & Laughlin and vice-chairman of its executive committee.

MORE COKE OVENS FOR GARY WORKS

▲ Construction of a new battery of coke ovens, adjacent to the coke plant of Gary Works of Carnegie-Illinois Steel Corporation, will be begun in the near future, it was announced recently. Carnegie-Illinois Steel Corporation will act for and on behalf of Defense Plant Corporation in the construction of these new coke ovens, and upon their completion they will be leased and operated by Carnegie-Illinois.

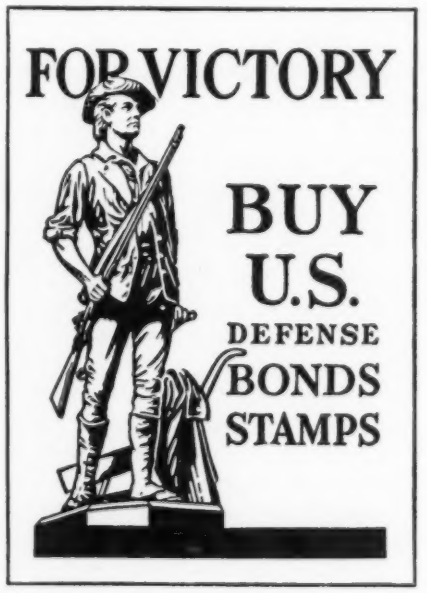
It is expected that the new coke ovens, which will have a capacity of about 400,000 tons of coke annually, will be completed and in operation in about a year's time.

AVAILABLE LITERATURE

▲ A new Industrial Equipment Catalog has just been published by S. F. Bowser and Company, Inc., Fort Wayne, Indiana, giving a comprehensive description of the range and extent of Bowser products. The equipment described covers the entire field of handling and control of industrial liquids, including filtration and distillation, lubrication, metering and pumping equipment, refueling systems, storage and dispensing equipment, etc.

▲ National Carbon Company, Inc., Cleveland, Ohio, has issued a new bulletin giving up-to-date information on National and Karbate carbon and graphite corrosion resistant pipe, tubes, and fittings. Included are data on physical properties, resistance to chemical action, and heat transfer, as well as listings of pipe sizes, types of joints, fittings and Karbate valves. This bulletin is available from the company upon request.

▲ Bulletin 1041, published by the Electric Controller and Manufacturing Company, Cleveland, Ohio, explains the company's Neo-Time-Current method of acceleration for push button operation of a-c wound rotor motors. The system of Neo-Time-Current control is thoroughly explained and the booklet is well illustrated with photographs, wiring diagrams, and performance curves.



"Techni"
PROCESS ROLLS

Other Mackintosh-Hemphill Products:

Rolling Machinery

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Strip Coilers

Shears

Levellers

Pinions

Special Equipment

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The NEW Abramsen Straightener

Improved Johnston Patented Corrugated

Cinder Pots and Supports

Heavy Duty Engine Lathes

More tons and lower cost per ton rolled; less slippage; greater bite; better surface and resistance to fire cracking—these are the profit making advantages you get with "TECHNI" Process Blooming and Slabbing Mill Rolls. These extra qualities are made possible by the "TECHNI" Process, an exclusive development of Mackintosh-Hemphill, which regulates the quality and grain size of the rolls with as much exactness as the best modern steel practice regulates the quality of steel.

Make your next set of rolls "TECHNI" Process.

Since 1803—Pioneers, Engineers and Builders

MACKINTOSH-HEMPHILL COMPANY . . . Pittsburgh and Midland, Pennsylvania

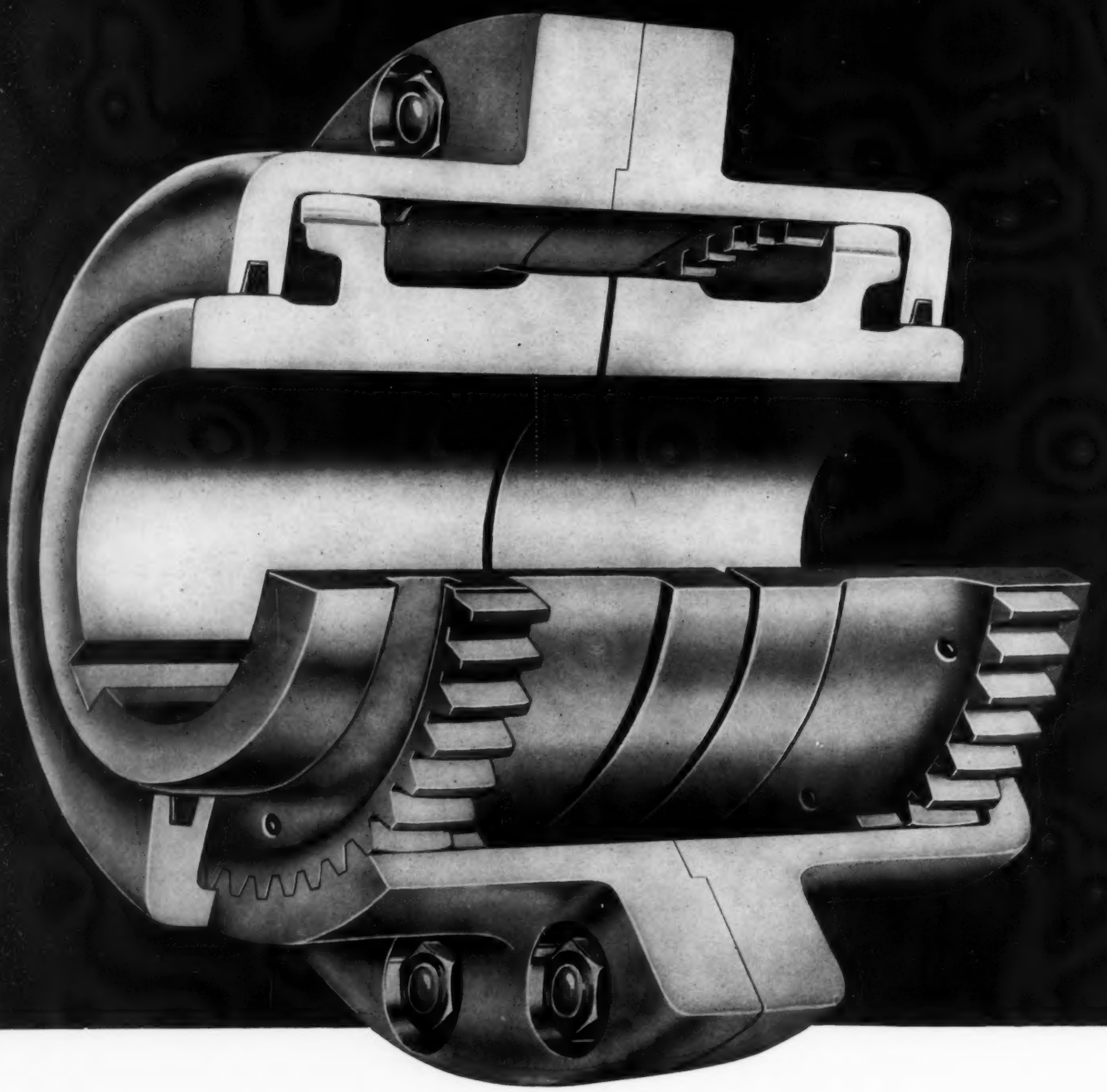
The Rolls With The Red Wabblers

They Roll More Tons Per Dressing

Steel and Alloy Steel Rolls

FOR BLOOMING AND SLABBING MILLS

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

ITEMS OF INTEREST

S. P. Kinney, formerly vice president of H. A. Brassert and Company has formed his own company, known as S. P. Kinney Engineers, to handle the manufacture, sale and installation of all accessory equipment

S. P. KINNEY

previously made and distributed by the Brassert organization. Headquarters will be at 233 Oliver Avenue, Pittsburgh, Pennsylvania.

H. S. Farmilo has been appointed field representative for the Trumbull Electric Manufacturing Company of Plainville, Connecticut, with headquarters in Baltimore — where he will work with **William J. Batchler.**

John Hulst, vice president of United States Steel Corporation and one of the best known engineers in the steel industry, retired recently upon completion of more than 40 years of association with United States Steel Corporation and its subsidiary companies.

C. B. Archibald, formerly St. Louis district manager of the Edison Storage Battery Division, Thomas A. Edison, Inc., has been appointed manager of the company's Pittsburgh office effective July 1, while **John J. Hughes,** former salesman with headquarters in the St. Louis district has been appointed to the St. Louis post.

Mr. Archibald entered the service of the Edison Industries April 19, 1933 as salesman in the railroad department of the company's Chicago office. On October 15, 1939, he was promoted to the post of St. Louis district manager, which position he held until his present appointment.

Mr. Hughes, who succeeds Mr. Archibald, acted as St. Louis district manager during Mr. Archibald's absence on special assignment earlier this year. Mr. Hughes' experience in the industrial storage battery field covers a period of more than 20 years, during which time he gained an intimate knowledge of the uses of batteries in industrial trucks, mine haulage equipment, railway passenger cars, and other industrial a. plications.

He was born in Columbia, Tennessee, and was graduated from high school in Nashville, Tennessee.

Joseph G. Broz, formerly sales manager for Baldwin De La Vergne Sales Corporation, has been appointed sales manager of the Diesel division of Baldwin. His broadened activities will include the management of all sales and service of both the diesel locomotive and the diesel engine business of Baldwin. Mr. Broz was born in St. Louis, Missouri in 1898 and has devoted many years of his buriness life to the diesel engine business. In 1922 he was placed in charge of sales of the Diesel division of the Fulton Iron Works Company of St. Louis, and in 1932 joined the De La Vergne Engine Company as district manager at Kansas City. In 1939 he became sales manager of De La Vergne, in which capacity he served until his recent promotion.

Henrik Ovesen, until recently chief engineer for the Division of Contract Distribution of the Office of Production Management, has joined Lukens Steel Company, Coatesville, Pennsylvania, as consulting engineer.

Mr. Ovesen will supervise certain engineering and construction to be carried out in connection with the war program. He was released by O.P.M. to assume this position.

Born in Copenhagen, Denmark, Mr. Ovesen received

HENRIK OVESEN

a degree in Mechanical Engineering from the Polytechnic Institute of Copenhagen.

In 1925 Mr. Ovesen joined Youngstown Sheet and Tube Company, Youngstown, Ohio, as chief engineer with which he was connected until 1935 when he engaged in consulting engineering work. He has supervised construction of several steel mills both in this country and England.

Burton H. Gedge, assistant to vice president in charge of operations, American Steel and Wire Company, Cleveland, has been promoted to new duties specializing in production activities of the vice president's office. **Harry L. Jenter** has been made assistant to vice president and will concentrate in office work for the vice president.

(*Please turn to page 94*)

CLEVELAND
all-welded cranes

HELP KEEP MILLS AT 100%

Cleveland all-welded cranes are proving themselves these days. That extra quality built into every Cleveland is now revealing itself through steel output records that far surpass all of years before.

For steel production of 100% and more, all equipment must function unfailingly. Cranes are no exception. It is of utmost importance that they keep going without delays. They cannot be held up for lengthy periods of service and repairs. Heavy loads must be handled quickly at every hour around the clock, day in and day out.

Now is the time to really get acquainted with cranes, in these rush days when they are pushed the hardest. As you get about in your mill or in others, check on Cleveland all-weldeds. Get a first-hand report of their merits for yourself.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283RD STREET • WICKLIFFE, OHIO.

MANUFACTURERS OF • CLEVELAND CRANES • CLEVELAND TRAMRAIL • STEELWELD BENDING PRESSES

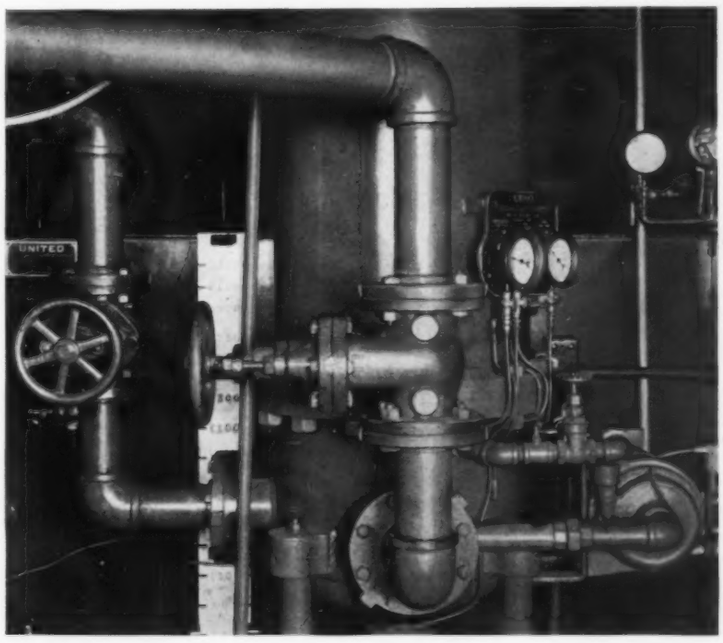
CLEVELAND *Steel Mill* CRANES

HOT AND COLD STRIP MILLS
that never need wait for Fluid-Cleaning

Lubricating systems, recirculating spray systems, roll body coolant systems, in the majority of continuous hot and cold strip mills, have Cuno continuous protection.

Cuno Filters positively remove all solids larger than specified — protecting bearings, spray nozzles and other parts from damage or clogging.

A special Cuno feature is the method of cleaning the filter element without interrupting the flow of liquid. Imbedded solids are removed as well as those adhering to the surface of the element, and the filter is made self-cleaning by means of a motor drive. There is no need to remove the element for either cleaning or frequent replacement.



1 LUBRICATING SYSTEM (*above*)

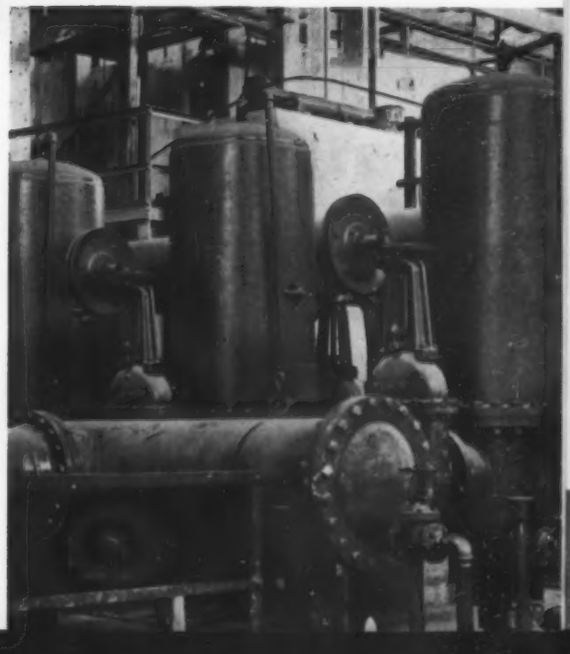
Cuno Auto-Klean Filter on 80″ hot strip mill, protecting gear reduction system — 435 g. p. m. o lube oil. Pinion stands, oil bearings and moto bearings on this mill are also Cuno-protected.

2 ROLL BODY COOLANT (*left*)

Cuno Flo-Klean on cold strip mill. Backwash i returned to the system — there is no loss of solubl oil or other valuable liquids.

3 DESCALING SPRAY SYSTEM (*below*)

Cuno Flo-Klean on 54″ hot strip mill, protectin spray nozzles from abrasive particles in spra water, permitting recirculation. 10,560 g. p. m.



A new bulletin, "Quick Facts," describes the Cuno Auto-Klean, recommended for lube systems, and the Cuno Flo-Klean (backwash type), especially designed to handle descaling spray and coolant systems.

KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

CUNO ENGINEERING CORPORATION

907 South Vine Street, Meriden, Connecticut

(*Continued from page 91*)

J. Dell Baster has been promoted to general superintendent, Cuyahoga works, while **Charles M. Sackerson** has been named superintendent of cold rolling mills, and **James W. Futhey,** general foreman of cold rolling at the Cuyahoga plant.

S. K. Towson has been named president and general manager of the Elwell-Parker Electric Company, following the passing of former president Morris S. Towson. At the same time, **W. A. Meddick** was named vice president.

Obituaries

Philip D. Block, former president and at the time of his death chairman of the Executive Committee of the Inland Steel Company died recently at the age of 71. Mr. Block had been president of the company for 22 years and had continued actively as chairman of the Executive Committee since April 30, 1941.

On November 10, 1893, Mr. Block was elected director and treasurer of Inland. In January, 1894, he became treasurer and purchasing agent and on July 9, 1901, vice president and treasurer. Eight years later Mr. Block was elected first vice president, and in 1919, became the fifth president of Inland.

Louis C. Edgar, assistant chief engineer of the Carnegie-Illinois Steel Corporation, died recently after a short illness

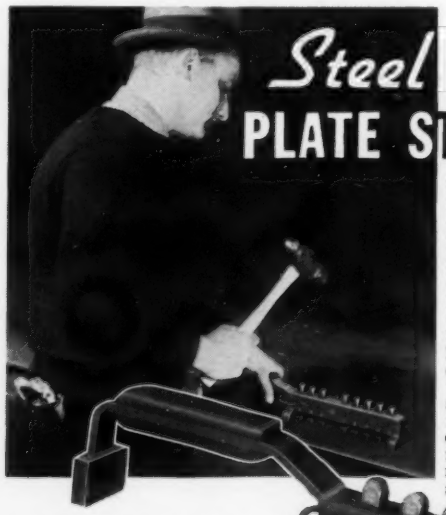
Mr. Edgar began his steel plant career in 1904 as a draftsman at the Edgar Thomson works. He was subsequently promoted to the position of assistant chief engineer, and in 1916 became chief engineer of Edgar Thomson works, holding this position until his transfer to the general office of the company in 1936 as chief engineer of the Pittsburgh district. In 1940 he was made assistant chief engineer of the entire Carnegie-Illinois Steel Corporation.

Mr. Edgar was an active member of the Association of Iron and Steel Engineers for the past 21 years.

Charles F. Brown, general foreman of locomotive and crane maintenance of the Great Lakes Steel Corporation, Ecorse, Michigan, for the past twelve years, died recently. Mr. Brown was formerly with the Cleveland Furnace Company and later dock superintendent of the Otis Steel Company. He was master mechanic of the blast furnaces at Wheeling Steel Company, Steubenville, Ohio, before going to Great Lakes Steel Corporation in 1930.

Frank H. Kittredge, formerly with the Carnegie-Illinois Steel Corporation and a charter member of the Association of Iron and Steel Engineers, died recently at La Jolla, California. Following his graduation in electrical engineering from the University of Minnesota, Mr. Kittredge worked at South Works of the Illinois Steel Company, until 1892, when he left to enter private construction business. In 1894 he returned to South Works where he remained until his transfer, in 1904, to Joliet Works of the Illinois Steel Company, later a part of Carnegie-Illinois Steel Corporation. He remained there as electrical engineer until his retirement in 1938, moving then to California where he resided until his death.

THE WAPAKONETA MACHINE CO.
Incorporated 1891 ~ Wapakoneta, Ohio.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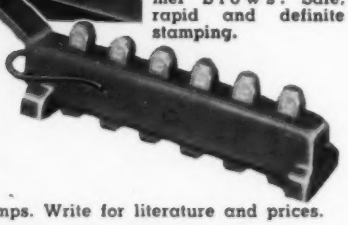
Slab section and sheared plate identification is rapidly stamped with Matthews Plate Stamping Holders. Of tool steel construction, they are light in weight and very durable. Easy to handle! The "Shepherd-Hook" holding device eliminates "wrong-side-up" stamps. Stamps cannot fall out or fly out on rebound from hammer blows. Safe, rapid and definite stamping.


Steel stamps are held in place by a properly tempered "Shepherd-Hook." They are quickly and easily changed. Holders are made for any required quantity of stamps. Write for literature and prices. State character size and number of characters to be stamped.

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P-G

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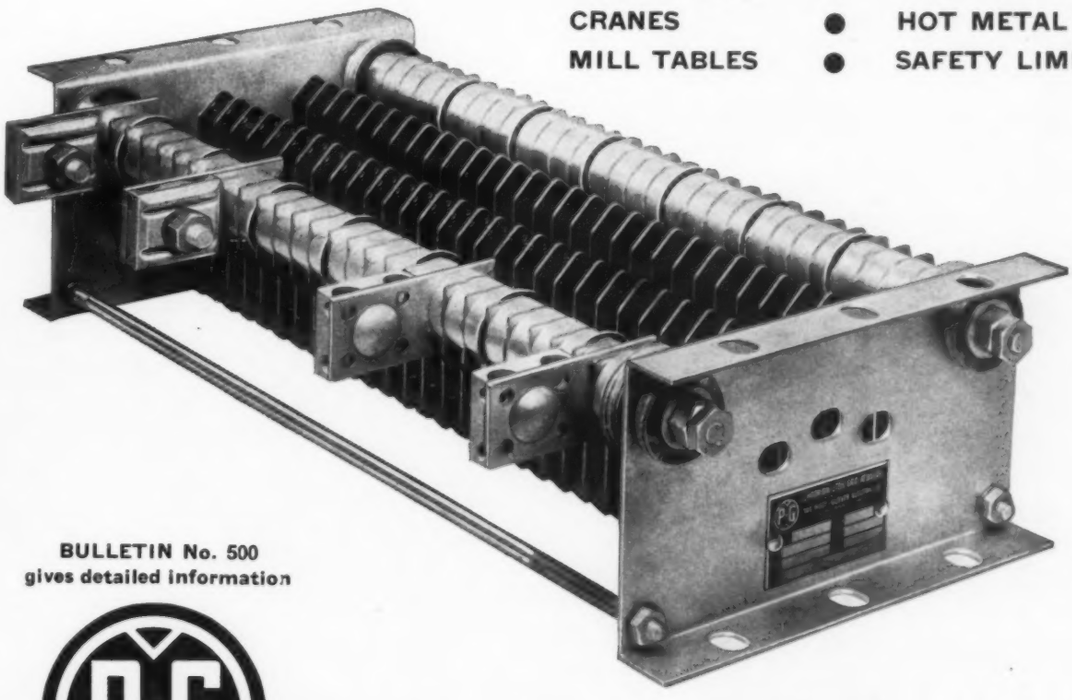

BULLETIN No. 500
gives detailed information

P-G

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Above is shown equipment for stripping alloy hot top ingots, consisting of two hydraulically operated ingot mold tilting machines, one 100-ton hydraulic stripper, and one mold car, all controlled by one operator. • Molds with ingots are transferred three at a time from pouring platform by multiple hook crane bale to mold tilter, are locked in position and tilted onto transfer car. • The ingot car conveys molds to stripper where they automatically engage with stripper head and are stripped, one at a time, to conveyor table. • After stripping, the molds are moved to second tilter to be returned to original upright position for removal to pouring platform.

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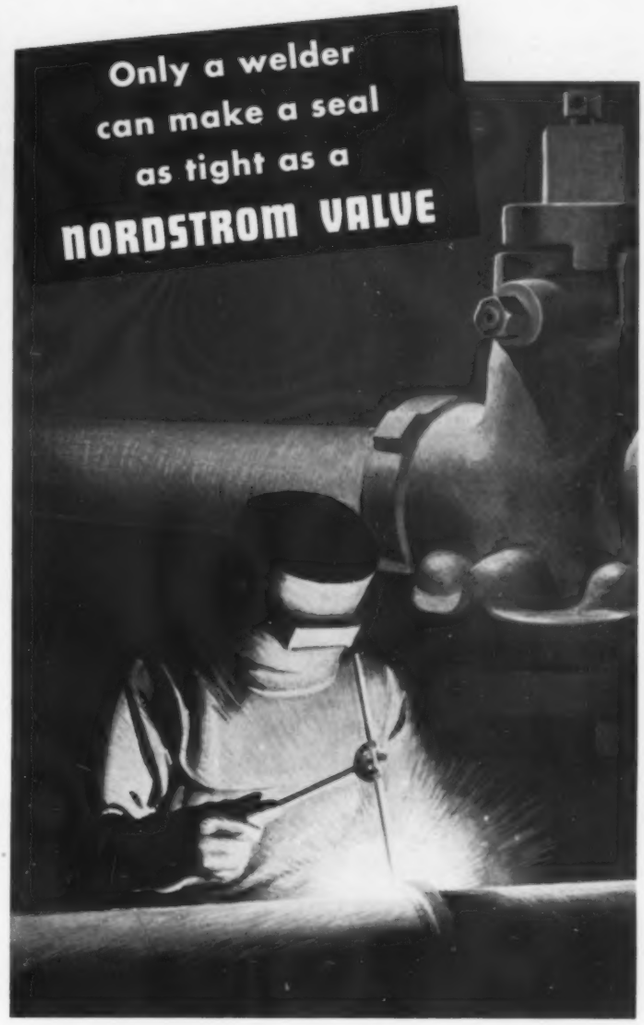

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keep upkeep down

Sizes:
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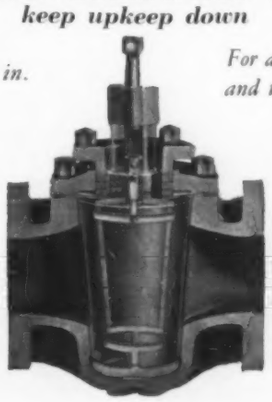

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Production is machine plus man hours. Both are lost when machines slow down or are forced out of operation.

Dripping, leaking oil cuts production. It won't stay in bearings, so does not lubricate dependably, and needs frequent application. Bearings run hot, waste power and often burn out. Machines and man hours are lost till service is restored.

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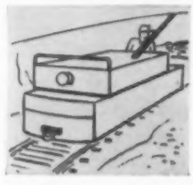
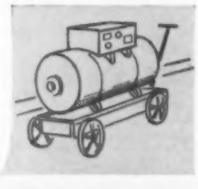
● Today's conditions demand that we keep our operating equipment at peak performance. To assist in this task National Carbon Company, Inc. issues a series of bulletins under the title "Modern Pyramids." These deal with practical information on Commutation, Brush Operation and Machine Maintenance to help conserve present equipment and keep it operating at full efficiency. If you are not already receiving these bulletins, write us direct or contact your National Carbon representative. He will be glad to assist you in interpreting the bulletins and in selecting the proper grade of "National" brush for most efficient operation of your motors and generators. The services of our experienced engineering staff are also available to users of "National" brushes for the solution of difficult brush problems.





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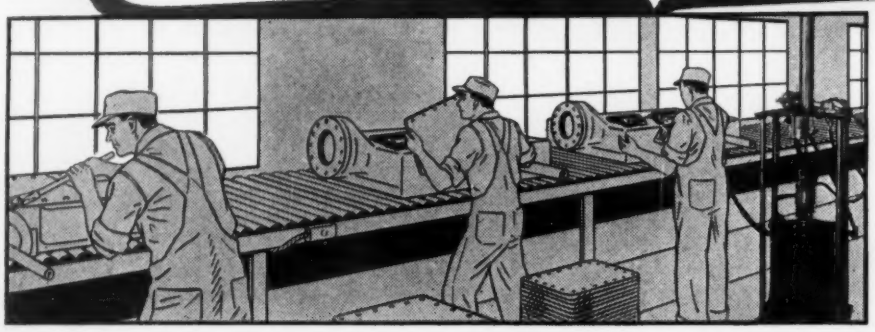
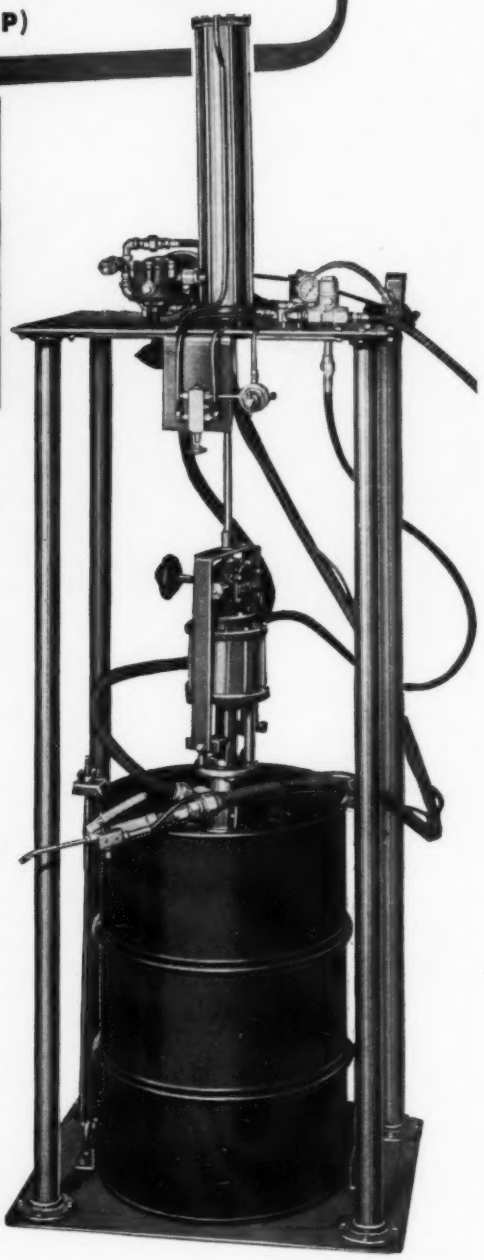
DISPENSE INSULATION, CAULKING COMPOUNDS AND SEALING MATERIALS *with the*
LINCOLN "PILE DRIVER"

(FORCED-INDUCTION PUMP)





WITH production surging to new highs, the men responsible for keeping schedules on the increase are searching for short cuts and time saving equipment.

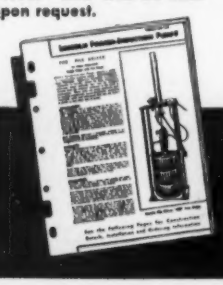
Lincoln engineers have recently perfected the Lincoln "Pile Driver." This unique pump is designed to dispense heavy viscous materials such as sealing compounds, sound deadeners, insulating materials, putty, heavy lubricants and other substances too heavy and solid to prime in any other type of pump.

Many of these units are now in service—on production lines where bearings or gears must have initial lubrication—in processes where assemblies must be sealed before riveting—in the production of special war products that must be gas and dust tight—in the refrigerator industry to apply sealing and insulating materials, etc.

Because of the ability of the Lincoln "Pile Driver" to deliver heavy materials direct from original containers to the point of application, this unit saves many man hours and material. Its use does away with the old stuffiing-by-hand, putty-knife and paddle methods of the past and speeds up production. In some cases, one man with a "Pile Driver" can do the work that formerly required several workers when the old methods were used. This saving alone will pay for the equipment in a short while.

Lincoln "Pile Drivers" are available in single or two-stage models, both employing the famous Lincoln Air-Motor. Two sizes can be furnished—the "100" for pumping materials from containers up to 10-gallons (100-lb.) and the "400" for pumping materials from 55-gallon (400-lb.) drums. Each can be arranged as a single stage or a two-stage unit depending on the requirements. The delivery of material is controlled, in both models, by a hand-operated shut-off valve at the outlet, and the flow is always under control of the operator.

BULLETIN 661
describes the Lincoln "Pile Driver" and will be sent upon request.



Special Engineering Service

These new pumps can be adapted to a wide variety of applications. Lincoln industrial engineers will gladly lend their knowledge and make recommendations as to how the "Pile Driver" can serve you.

142-11

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Pioneer Builders of Engineered Lubricating Equipment
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For complete information on Deltabeston Wires and Cables, write to Section YR-721-31, Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn. Deltabeston Wires and Cables are distributed nationally by Graybar Electric Co., General Electric Supply Corp., and other G-E Merchandise Distributors.

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A SINGLE OBJECTIVE.....

Production Control

A SINGLE RESPONSIBILITY IN ACHIEVING IT

Higher tonnage and uniform quality of product result from efficient control of steel mill equipment. An invaluable aid in achieving this is a system of automatic controls and instruments that allows operators to concentrate on the factors making for optimum production. To secure these results, Republic Flow Meters Co. offers a complete manufacturing and engineering service—a single responsibility—in the field of measurement and control. We will gladly co-operate with you in the solution of any metering or control problem. Your inquiries involve no obligation.

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For furnace pressure, fuel, fuel-air ratio.

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Let F.B.I. *protect*

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A treacherous, insidious saboteur lurks in every plant engaged in war production, alert to every opportunity to damage your machines and curtail your output. FRICTION is his name, and your only safeguard against him is the vigilant protection of F.B.I.—FREQUENT BEARING INSPECTION.

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We will gladly cooperate with you in maintaining or increasing your production—by experienced counsel on the use and care of anti-friction bearings, and by supplying you, wherever possible, NORMA-HOFFMANN PRECISION BEARINGS for replacements.

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FOUNDED 1911

PRECISION BALL, ROLLER AND THRUST BEARINGS

IN COMBINATION STARTERS by the THOUSAND

CIRCUIT BREAKERS are by I-T-E

These are readily identified as the work of I-T-E

Steel-enclosed switchboards and individually mounted circuit breakers have carried the I-T-E symbol into the plants of industry. These units represent the work for which I-T-E is known. But, as the text at the right indicates, the field of I-T-E usefulness is even broader.

COUNTLESS TIMES every day, operators of motor-driven machines press the buttons which call vital motors into action. In a very great many instances, in so doing, the operator is calling I-T-E into his service. For within the housing of the combination motor starter, hidden away behind a solid metal door, is an I-T-E circuit breaker, the protector of the current-carrying system.

Combination motor starters built by leading manufacturers do their work so well that there is seldom need for close examination within the starter case. As a consequence, this important and widespread service on the part of I-T-E has been little known.

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Make a mental note. Add this motor-starting activity to what you already know of the half-century of work by I-T-E in the design and manufacture of air circuit breakers and switchgear.

I-T-E

AIR SWITCHGEAR

IMMERSED IN AIR • ENCASED IN STEEL

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Representatives in Principal Cities

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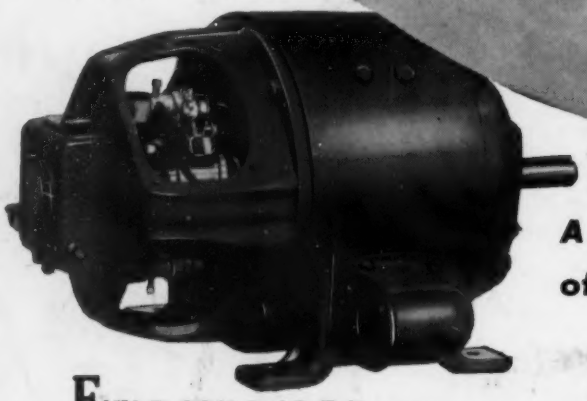
See How INSULATION STRENGTH Is Built into These D-C FIELD COILS



A Feature of this D-C Motor

FIELD COILS of G-E direct-current motors are wound with FORMEX (Reg. U. S. Pat. Off.) wire for two important reasons.

1. Coils wound with Formex wire—the toughest magnet wire yet developed—have extraordinary resistance to abrasion, heat shock, mild acids, and alkalies. Hence the field coils are built to have strength against any possible short circuits or failure.

2. Coils can be made more compact when wound with Formex wire. This increases heat-dissipation ability, allows more ventilation space, and reduces possibility of a burnout or "hot spot."

This is only a small part of the story on the new General Electric d-c motor, however. Why not get full details on the entire motor—from built-up commutator and heavy-duty brush rigging to such convenience features as easy reversal without changing any part of the frame, fan, or brush rigging? Call or write your G-E representative for complete information. And be sure to send for your copy of the latest bulletin on d-c motors, GEA-1542E. General Electric Company, Schenectady, N. Y.

Unusual Construction of Commutating Field Coils of Smaller Motors

A Textolite box covers the laminated-steel pole piece and is tightly molded into shape under pressure. Tough Formex wire coils are then wound compactly on this assembly. They are then bonded with a thorough, baked-in impregnation of synthetic resin. This results in a rigid, nonchafing, long-lasting assembly.

LOOK TO G.E. FOR D-C

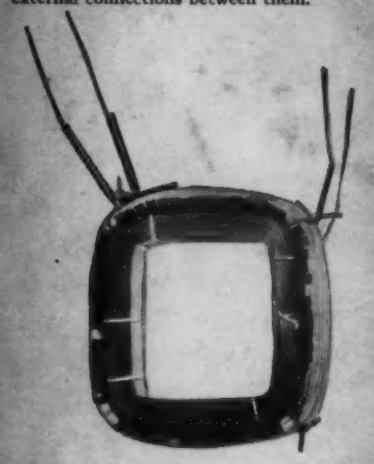
GENERAL ELECTRIC

TIS-T1-8298

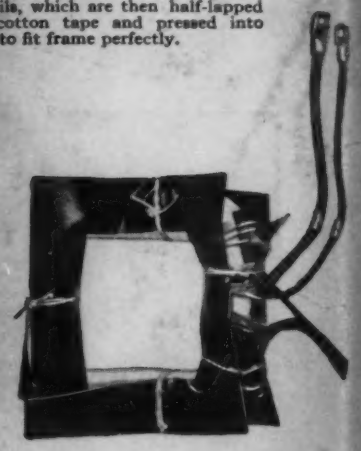
4 STEPS IN THE MANUFACTURE OF THE MAIN FIELD COIL*

(showing the care taken to make the insulation as nearly failure-proof as possible)

Both shunt and series portions are wound with tough Formex wire, in those ratings for which the right Formex wire sizes are available. Coils are wound in pairs, eliminating external connections between them.



Layers of varnished cambric separate the coils, which are then half-lapped with cotton tape and pressed into shape to fit frame perfectly.



Varnished cambric is again applied—to both sides of the coil for additional protection.

After final cotton taping has been applied, coil is thoroughly impregnated with insulating varnish, baked, and given a final, heavy coat of 1201 Glyptal Red. *This complete treatment cements the coils into a solid mass that offers high resistance to electrical breakdown or mechanical injury.*

**50-hp motors and smaller*